SCIENTIFIC AMERICAN

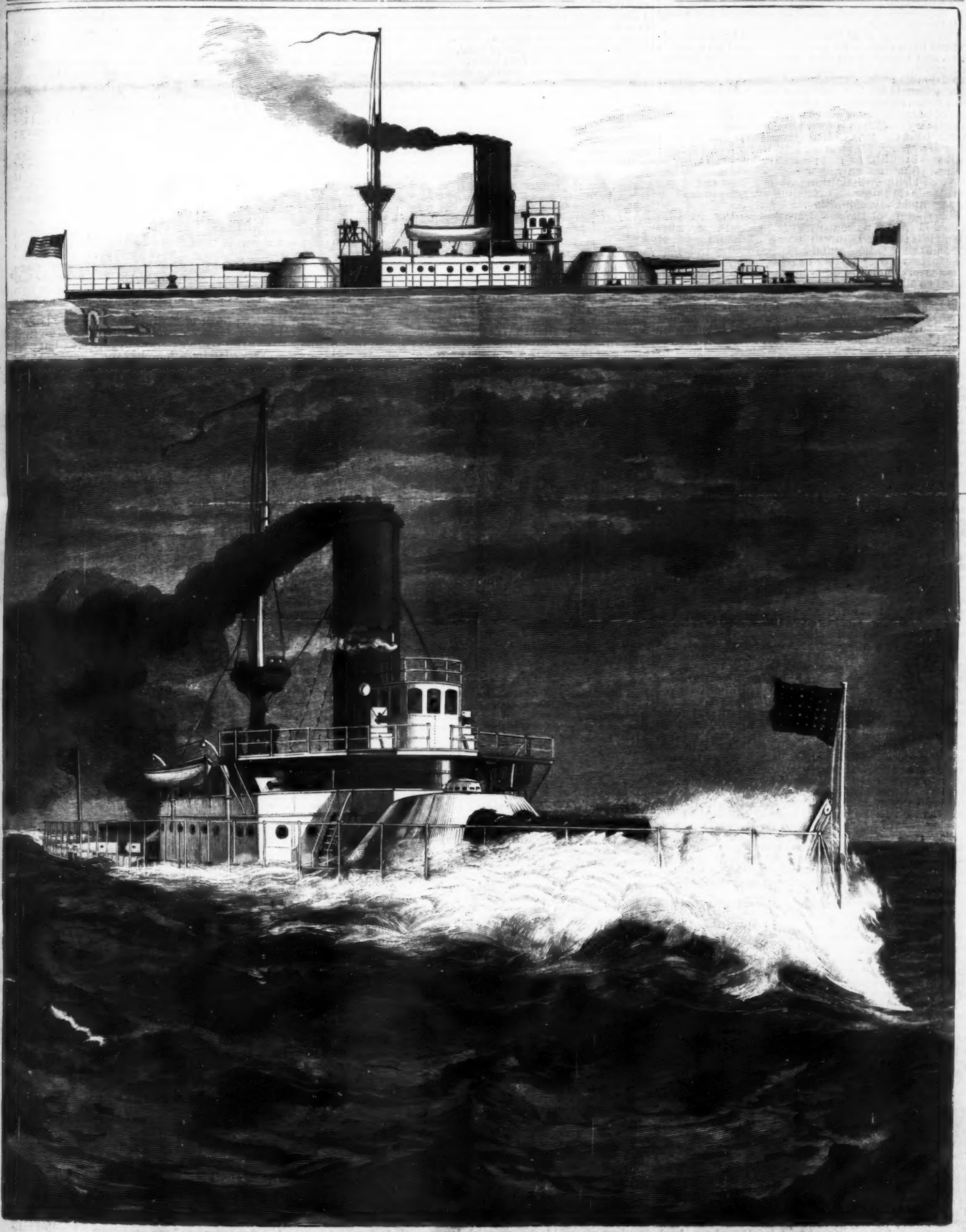
SUPPLEMENT No. 896

Copyright by Munn & Co., 1893.

Scientific American Supplement, Vol. XXXV. No. 896
Scientific American, established 1845.

NEW YORK, MARCH 4, 1893.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.



OUR NEW WAR STEAMER THE MONTEREY, BUILT AT SAN FRANCISCO.

THE MONTEREY.

THE new double turreted, twin screw, armored coast defense vessel illustrated on our first page was launched in May, 1891, at the Union Iron Works, San Francisco. She is designed to afford a floating defense of the highest character for the magnificent harbor of San Francisco, while also available for similar service anywhere on the coast, and would probably have been named after the principal city, had not this name been already given to a new cruiser. As it is, she takes the name of the coast town which was the capital of Upper California when the territory was taken possession of by the United States, more than forty years ago.

The bids for the construction of this vessel were opened April 3, 1889, the Cramps, the Quintard Iron Works, and the San Francisco Union Iron Works being competitors, the contract being awarded the latter firm on their bid of $1,628,950, with the provision that $100 will be paid for every unit of horse power over the stipulated amount, and $100 deducted for every unit less than this.

The Monterey is of the low freeboard type, presenting but little surface to receive the fire of an enemy's guns, and has a curved steel deck to give her further protection. She is constructed entirely of steel, and has a double bottom throughout, with 110 watertight compartments in her hull that can readily be filled with water, submerging the vessel until only about one foot of her sides shows above water. Her displacement in ordinary condition is 4,000 tons, but in fighting trim it will be 4,486 tons. Her general dimensions are: Length over all, 261 feet; on load water line, 256 feet; extreme breadth, 59 feet; mean draught, 14 feet 6 inches. She has an armor belt which is 13 inches thick amidships, diminishing at the bow and stern, the maximum thickness extending over the steam machinery and the ammunition.

The engines of the vessel are designed to give 5,400 indicated horse power, with forced draught, with which it is expected she will show a maximum speed of fifteen or sixteen knots, and be able to carry sufficient coal to travel over 600 miles at this speed, her coal endurance at the rate of nine knots per hour being designed to allow her to cover a distance of about 2,700 miles. She has no sail power, her single military mast being solely for observation and signaling, and to carry machine guns and a search light. The propelling engines are triple expansion, the cylinders being 27, 41, and 64 inches diameter, respectively, and the stroke 30 inches, there being two of these engines, designed to work the twin screws at a speed of 150 revolutions per minute on a steam pressure of 160 pounds per square inch. There are two main steel boilers, 11 feet 2 inches diameter and 10 feet 7 inches long, each, and four smaller tubular boilers. The fire room is under pressure to give the forced draught when that is required, and the ventilation throughout is effected by a large blower, doing away with all funnels. The hatches are closed by hydraulic cylinders. The electric light plant consists of three units, each unit embracing an engine, dynamo, and combination bed plate, and several search lights.

The armament of the vessel is as follows: Two 12-inch breech loading rifled guns, with 13-inch steel armor protection and steel shields eight inches thick, each firing a projectile weighing 850 pounds, with a powder charge of 425 pounds; two 10-inch breech loading rifles mounted en barbette, with 11½-inch steel armor protection and steel shields 7½ inches thick, each firing a projectile weighing 500 pounds, with a powder charge of 250 pounds. There are also six 6-pounder rapid firing rifles, four 37-millimeter Hotchkiss revolving cannon, and two 1-pound rapid firing rifles.

The Union Iron Works, where the Monterey is being completed, has for a long time occupied a leading position in the manufacture of mining machinery, and was in 1885 moved to South San Francisco, where, on a tract of fifteen acres, a great plant has been established, as is attested by their highly successful work in building government war vessels. The dimensions of their great stone dry dock are as follows: Length of excavation in solid rock, 450 feet; depth, 120 feet; width of entrance, 30 feet; width of top, 120 feet; capacity of pumps per hour, 335,368 cubic feet. Its cost was $675,000. Henry T. Scott is president and treasurer of the corporation, and Irving M. Scott is vice-president and general manager.

The official trial trip of the Monterey took place in the Bay of San Francisco, January 5, 1893, and was entirely successful. Approximate computations were made as soon as the run was finished which showed a development of 5,452 horse power on the main engines alone. Horse power of the auxiliary engines is estimated at 100 to 200. Both contractors and the naval engineers who were on duty during the trial are confident that the 5,400 horse power required by contract has been exceeded, and they express entire satisfaction with the performance of the engines.

During the four hours' run under a forced draught there was not the slightest accident to any part of the machinery. The maximum revolutions were 168 a minute, and the average for four hours was about 162. As there is no speed requirement in the contract, no great effort was made to ascertain the extra speed of the vessel during her run, though the patent log was in use all the time that she was under way, and a number of shore bearings were also taken.

The examining board, it is understood, was warm in its praise of her construction and the ease with which she obeyed the rudder. What the builders could not prevent was a terrible rush of water over the bows, which even at a moderate speed were submerged. Experts say that bulwarks will be found necessary.

THE GAS ENGINE.

THE gas engine in appearance is very like the common steam engine in many respects. It has its cylinder, its piston rod, and its fly wheel. The method of operation is essentially different, however. The cylinder, for instance, has no head at one end, the end nearest the fly wheel being open. Gas is admitted into the cylinder back of the head of the piston rod. A flame, which is kept ignited all the time, explodes the gas as soon as it is admitted. The force of the explosion is what drives the piston rod out with great velocity and power. So great is the power of the explosion that there is no need of a similar movement to drive the piston back, the momentum of the fly wheel and the vacuum created after the explosion sufficing. As soon as it returns the same operation is repeated automatically, thus keeping the fly wheel in constant and even motion. The supply of gas regulates the speed of the engine. A set of ingeniously arranged governors regulate the supply of gas. This is the principle of the gas engine.

Men who have spent a lifetime in the engine room are the ones to ask whether the gas engine has any advantages over the steam engine or not. Here is what Engineer W. H. Cate had to say about it: "For many years I was engineer in a factory where the machinery was driven by a steam engine. It was hard work all the time. There were ashes to handle, coal to throw in, dirt and dust to clean up, and a dozen other things to do as a result of using coal. Now I am engineer of this plant," he said, referring to the one in which your correspondent met him. "I come here in the morning and light a little gas jet you see beneath the cylinder. I start the fly wheel around once, and that is all there is to do. The moment the gas is turned on the engine runs, and will keep running till I turn it off again. There are no fires to bother with, no dampers to regulate and no ashes to cart away. About once a month I wipe the engine over with a cloth, and that is all the cleaning that is necessary. It is a great improvement over the steam engine."

It requires time to get up steam with coal. Fuel must be burned in the meantime, and it must also remain burning some time after the engine is stopped for the night. This waste of heat does not occur in the gas engine. The gas engine is always ready to start without previous preparation, and the supply of gas is shut off the moment the engine stops for the night. Again, the gas engine can be put in places where it is inconvenient or impossible to have steam engines or to obtain power from outside, such as work rooms and small shops in city buildings. In this respect it becomes a competitor of the electric motor.

The important point is, does the manufacturer gain anything financially by the use of the gas engine? In these days the manufacturers care more for a saving of money than for a saving of labor. According to the information that we gather from a dozen different sources in Boston and vicinity, there is a saving with gas at $1 per 1,000 ft. of about 11 per cent. in cost of fuel where the gas engine is used instead of steam. In some places it is said that the cost of gas and steam power were the same, in other places it was stated that a saving of 10 per cent. was made by the use of gas, and some went so far as to claim a saving of 25 per cent. A little figuring on the above estimates, as given by various men under various conditions, gives an average very close to 11 per cent.

Information on this subject as given by the builders of gas engines may be of interest. Here is what they say: "A fifty horse power engine can be run at a high speed at a cost of only 2 cents per hour per horse power, where the cost of gas is $1 per 1,000 ft. The cost per hour of driving the same engine by steam power is more."

If extensive sales of gas engines indicate anything in their favor, then they must be well liked wherever used, for every builder and dealer reported that the demand for these engines is good. It seems that three to ten horse power engines are the favorites. These are being sold for use in the printing office to a great extent. Butchers are buying the machines to chop meat with. Stock men use them to pump water. Knitting and sewing machine factories are puting them in. Yachtsmen are running their yachts with them. There is a bright future for the gas engine.—*Com. Bul.*

STEEL IN ROLLING STOCK.

AT a recent meeting of the New England Railroad Club, Mr. George Richards read a paper on Steel vs. Iron.

After referring to the long period during which iron had been used, he agreed that steel castings were very much superior to iron castings, in many cases even superseding forgings. Driving wheel centers of cast iron frequently break, while cast steel are far stronger and little liable to flaws. Letters from many prominent steamship and railroad corporations show that steel castings are being very extensively used.

Mr. Kent: Will steel weld as well as good iron? Will steel coupling links weld as well as iron ones with one process?

Mr. Richards: The welding of steel has been long known; any metal, if heated to a certain temperature, the metal being clean, will unite perfectly. The failure of welds, especially with iron, is owing to the metal not being entirely clean and clear.

Mr. Chamberlain: Would it be practicable in welding steel on a large scale to work it as wrought iron is worked, at slight additional cost, say to turn out a thousand tons of coupling links a day?

Mr. Richards: If coupling links could be made without a weld, it would be a great improvement. Steel is forced into use rapidly where it is practicable to cut out articles in a single piece. Avoid welding where possible, especially in steel bridge building, as a weld may be sound outside and defective within.

Mr. Lauder: The best metal to use in the construction of railway rolling stock is a question of the experience and prejudices of the men engaged. Steel is far superior to iron for boilers of any kind, although within a year some of our Western friends have put in some iron fire boxes. Steel, however, is now abandoned for stay bolts; it would not stand, although so much stronger than iron by scientific test. Where the material is subjected to reciprocating strains, as in piston rods, crank pins, connecting and parallel rods, iron will stand much better than steel. The design is important. A piston rod with a square shoulder is bad design; it should be of equal size the whole length, and then there are no weak parts where the strains will concentrate and produce rupture. A parallel rod to bear the strains put upon it requires a fibrous material like iron, which is far better than steel for that purpose. Our steel rods break every few days, both parallel and piston rods, and we are abandoning them on our road. A good steel crank pin, if large enough so that there is no spring to it, will last forever, but if of small enough design to admit of any spring whatever, it will break in time, while under these conditions an iron pin will last very much longer. So to jump at a conclusion and say that steel is better than iron for all purposes of rolling stock construction is very unsafe.

Iron driving wheel centers break on account of the design of the centers. Some of Mr. Richards' statistics are gathered from European sources, but it is well known that they have not there the strong cast iron we have in this country; they do not use chilled car wheels, because they have not the material to make them of. A cast iron driving wheel center made of such material as we have in this country, of such iron as we put into cylinders, and properly proportioned, will last almost indefinitely. I remember forty years ago, it was a very rare thing for one of the Hinckley driving wheel centers to break, and they were very light compared with what we use to day. Later, wheel centers of an entirely different design were made and many have broken. It is not wise to condemn cast iron driving wheel centers because somebody has made a poor design and they have broken. For other parts of the locomotive steel is undoubtedly better than iron. A steel crosshead is preferable to one of iron, for the strains put upon it are so severe that almost any design of cast iron crosshead will sooner or later break. Steel or cast iron crossheads run between guides will wear rapidly. The best material for this purpose is Eureka steel, made in Chester, Pa. It is a first class quality of cast iron, and the surface is converted into a metal similar to steel and made stronger. Steel for guide bars has been displaced by cast iron. Steel for piston heads has not been much used in this country; cast iron wears much less rapidly.

No quality of steel will make as strong and safe a bolt, where a thread is cut on it, as a good quality of iron, because one of the peculiarities of steel is that if it is nicked even with a file it is liable to break when subjected to shock, and this feature would make it objectionable for many uses in connection with cars. Truss rods and arch bars, I think, would be as safe with a fairly good quality of iron as with steel. Steel rivets for boilers have made no headway; they have been tried repeatedly in locomotive construction; the heads are more apt to fly off than where they are made of a good quality of iron. Though steel has more torsional strength than iron, it has not proved to be a better material for all purposes of locomotive and car construction.

Mr. Marden: Steel is destined to enter very largely into car construction. A number of years ago we tried some steel axles without very good success, but steel was then very high in carbon, but there has been very great progress in its manufacture of late years. We want in car construction a metal that will give the greatest strength with the least weight. If bolts or rods can be produced in steel that is equal to the best iron, and can be used much lighter than iron, it seems to me they would be preferable. My experience has been the same as Mr. Lauder's with certain grades of steel. Where it has had very high tensile strength it has broken in reciprocating strains. In building some freight cars a number of years ago we found by a series of tests which we had made at the Watertown arsenal that we could use a very much thinner steel, and nearly one-half lighter, for certain parts in the truck than we could of iron, and at the same cost. Steel is now produced that is much better in certain parts of car construction than iron, and costs less. This is directly contrary to my experience of ten or twelve years ago in the matter of car axles. I was then decidedly opposed to its use, but the manufacture of steel has been much improved.

Mr. Adams: I am in favor of the use of steel in car construction except for axles, as some we used a number of years ago certainly broke more easily under the same strain than iron axles made of good material. Steel axles wear faster than iron. Steel might be used for arch bars, retaining the present size and get the additional strength, because our tonnage is increasing continually, and we cannot make our cars too strong. We have used many steel truss rods during the last two years successfully.

Mr. Marden: In 1886 we bought rough-turned axles with the journals forged out ⅛ or ¾ in. larger than the size required. An axle forged ½ in. larger than the journal would wear much better and heat less than the others; probably because the journal being forged down close, we did not turn off enough of it to get to the soft part of iron. Steel axles to-day are very low in carbon and are only an improved iron.

Mr. Lauder: Steel castings will soon supersede expensive and intricate forgings, as the result of trials is very satisfactory. The steel castings are sound and very much smoother and nearer the size and shape required than forgings; consequently the cost of finishing less. Steel castings can now compete with forgings in price, and for many parts can be substituted for iron forgings with advantage, as they are easier to finish, and there is less waste of material in finishing.

A steel journal wears faster than an iron one, because it is softer, though more dense. It is granular, while iron is fibrous. Others reason that there are more hot boxes with it, because it is too dense to get good lubrication.

Mr. Sinclair: Steel axles do not heat faster than iron. It is very important when a steel axle is specified to see that it is the right kind of a steel axle. Many railroad men, master mechanics and master car builders, have specified steel axles and said nothing more about it, and they got in nearly every instance Bessemer steel, which is unfit for axle purposes, and therefore many failures of steel axles have been attributable to the use of material unfit for the purpose. Mild steel such as you would put into any structure which requires reliability will run as well or better than iron axles. On the New York Elevated weights are reduced to a minimum, and axles as light as possible are used. Iron axles broke, and they have now used steel for ten years exclusively. The records show that steel will break after a certain mileage. They know within 10,000 miles when a steel axle is liable to break. Iron would sometimes give twice the life of steel, and sometimes only one-tenth. Consequently they consider steel safer than iron. They have no difficulty in lubrication, and the journals run as satisfactorily as iron, and they consider steel preferable, as it is stronger and it has a known life. The tendency is for iron to get poorer and steel to get better. The development of steel castings in the last five years has been enormous. English rail-

ways are now using steel castings of their own make. Steel manufacturers here make a satisfactory product. An iron axle will show signs of a coming break before a steel axle will. Steel axles break by minute concentric cracks, not circumferentially around the journal, but eccentric, the center of the break being an inch or two from the center of the axle.

Mr. Graham: The West End Railroad have now 1,700 cars equipped with steel axles. They never heat, and give good satisfaction. If electric railroads find steel axles better than iron ones, the cars bounding along as they do, carrying ten tons and the motor four tons more, I think the steam railroads would get the same result.

Mr. Sinclair: Steel axles are used very largely by the Pennsylvania under passenger equipment, and they run trains about as fast as anybody, and there is scarcely anything else used in Great Britain, where the railroads are under close supervision as to the material used; so the use of steel is not confined to slow service.

THE NEW STATION OF THE PHILADELPHIA AND READING TERMINAL RAILROAD, PHILADELPHIA, PA.

THE train shed of the passenger station of the Philadelphia and Reading Terminal R.R. at Philadelphia, Pa., has, says *Engineering News*, the greatest single span arched roof of any train shed in the world; and, indeed, so far as we recall, only two arched roofs of greater span have ever been constructed. These are the roofs of the Machinery Hall at the Paris Exposition of 1889, with a span of 364 ft. 2 in., c. to c. of end pins, and of the Manufactures Building for the World's Columbian Exhibition, at Chicago, with a span of 368 ft., c. to c. of end pins. The only other train shed yet built whose dimensions very closely approach those of the Philadelphia and Reading Terminal train shed in magnitude is that built at Jersey City, N. J., in 1891, for the Pennsylvania R.R. Co. It should be noted, however, that the roof arches for the Broad Street Station train shed, which the Pennsylvania R.R. Co. will erect at Philadelphia, Pa., will have considerably longer spans than those of the Philadelphia and Reading Terminal R.R. train shed, viz., spans of 606 ft. 9⅝ in., c. to c. of end pins. Prior to the construction of the Pennsylvania R.R. train shed at Jersey City the largest single-span train shed in the world was that of the St. Pancras terminal station of the Midland Ry., in London, England, which was built twenty-four years ago.

The comparative dimensions of these three structures, as far as we have been able to collect them, are shown in the following tables:

	P. R.R. Ft. In.	P. & R. R.R. Ft. In.	Mid. Ry. Ft.
Span of roof trusses, c. to c. end pins.	252 8	259 0	240
Clear height at center.....	86 0	88 0	100
Clear width of train shed, out to out.	256 0	266 0	
Length of train shed, out to out.....	652 6	506 8	690
No. pairs of roof trusses	12	11	
No. of tracks inclosed...	12	13	10*

* Including a 25 ft. roadway.

The station is located at the corner of Twelfth and Market Streets, fronting on Market Street and extending to Arch Street, crossing Filbert Street. The head house has a frontage of 266 ft. 6 in. and a depth of 100 ft. It is eight stories high with a half basement. The basement and first stories are built of pink granite and the remainder of pink brick, with white terra-cotta trimmings. The architecture is Italian Renaissance. The trains enter the train shed by an elevated structure, so that the platforms are on a level with the second floor of the head house. Filbert Street runs underneath the tracks, dividing the basement into two parts. The part from Market Street to Filbert Street is used by the railway company for station purposes, and the part from Filbert Street to Arch Street is utilized for a public market. Above the train floor the building is fitted up for office purposes. The building is intended to embody, so far as is feasible under the circumstances, the best arrangements and latest improvements applicable to railway passenger stations.

From an engineering standpoint, however, the greatest interest attaches to the iron work of the train shed. The principal dimensions of this structure are: Length, 506 ft. 8 in.; width, 266 ft.; height, c. to c. of pins, 88 ft.; and height from the top of the rails to the top of the skylight, 95 ft. The whole weight of the roof is carried by 11 wrought iron roof arches, with riveted joints, each having a span of 259 ft. between centers of end pins. Each arch is formed by a pair of parallel trusses placed 5 ft. apart, c. to c., and braced vertically and horizontally. These arches are connected by side trusses and purlins, and between each pair of arches are placed two jack rafters connected rigidly to the purlins by riveted joints. The pair of arches at each end of the structure are also connected by a system of lateral wind bracing, running from the end of each purlin to the opposite end of the one next above. The intermediate arches are braced between the side truss and the first purlin only, the other laterals being omitted.

The structure is further strengthened to resist the pressure of the wind by a horizontal wind truss, with curved chords, running longitudinally across the first arch at the Arch Street gable. This truss is riveted to the lower chord of the main arch trusses at the elbow of the arch, and is suspended from the lower chord of the trusses by hangers.

The main arches are, as before mentioned, composed of two parallel trusses, braced together with angle iron. Each truss, comprising one-half of the arch, is built up of wrought iron plates and angles, with riveted joints, and is hinged at the apex and at each foot. One of the feet is also provided with a shoe carrying a nest of expansion rollers to permit free movement with changes of temperature. It is divided into twenty-four panels from shoe to apex.

The main feature of this truss lies in the fact that the individual chords between panel points are curved to conform to a true outline of the arch, requiring exceedingly nice work in shop construction. In this lies the essential difference in design and construction between these arches and those composing the Pennsylvania R.R. train shed at Jersey City. The plates and angles of the chords are connected by a series of splices. The splices of the top, or tension chord, are made by breaking the chord angles and the covers and web plate at different points, thus forming a connection which would otherwise require heavy and long splice plates. The bottom or compression chord is spliced with ordinary square butt joints, the bottom cover plate, however, always extending beyond the joint to avoid the use of a short and unsightly splice plate. These splices are so arranged as to divide the truss into sections, in which shape they were transported from the shops to the field, where they were riveted together as erected.

The lower chord of each arch is composed of 4 in. × 1½ in. eye bars, connecting the pins at the shoes and running underneath the track. The pin at the apex of the arch is 5 in. in diameter and 2 ft. 2¼ in. deep, running parallel to the main arches. These rafters have the same curve as those at the feet—are 5 9-16 in. in diameter each.

The purlins connecting the roof arches, and upon which the wood and tin roofing is laid, are wrought iron lattice girders, eleven in number, five on each side and one at the ridge. They are each 44 ft. 9½ in. long and 4 ft. deep, built up of four 5×3½ in. 35 lb. angles, with 3×2¼ in. 17 lb. angle latticing. To those connecting the first and second and tenth and eleventh arches are riveted plates, with a pin hole, to which the lateral bracing, consisting of square upset rods, is fastened by a clevis.

At right angles to and riveted to the purlins are the jack rafters, which are also lattice girders, arches, and extend down and connect with the side trusses. They are placed 15 ft. 2 in. apart, c. to c., two between each pair of arches, and are connected at the apex by a riveted connection at the ridge purlin, at which point allowance is also provided for expansion and contraction. The lateral bracing is connected to the jack rafters by ⅝ in. plates, riveted to the upper flange of the girder, through which at each end a pin hole is provided for the attachment of the clevises.

The train shed is built throughout of wrought iron and cast iron. The specifications for the quality and workmanship of the cast iron work, of which there is but little, do not differ from those ordinarily provided for work of this character. All wrought iron used in the tension members of open trusses, and in all laterals, pins, bolts, etc., was required to be rolled directly from the muck bar and to have an ultimate strength of 52,000 lb. per sq. in. on a full section of test piece; an elastic limit of 26,000 lb. per sq. in., and a minimum elongation of 20 per cent. in eight inches.

The specifications for workmanship did not differ materially from those usually provided for first-class structural work. All the iron work was to be thoroughly scraped and cleaned after erection, and given one coat of red lead in pure raw linseed oil.

The train shed was designed by Wilson Bros. & Co., of Philadelphia, Pa. The Phœnix Bridge Co., of Phœnixville, Pa., were the contractors for the iron work and erection, and all the details of the travelers and methods of erection, which are usually interesting, were designed by their engineers.

HORSE POWER OF STEAM BOILERS.

By WILLIAM GOLDING.

FROM a careful examination of all the books on the subject of horse power of steam boilers, I am of the opinion and can safely assert that there never has been, nor is there now, any rule for estimating the horse power of steam boilers other than that based on the square feet of heating surface; neither can I find that there has ever been any change in the heating surface required per horse power in the early days of steam boiler construction, namely:

9 square feet of fire box surface
9 " " " shell "
12 " " " flue "
15 " " " tube "
} = { One horse power.

I am aware that the Franklin Institute, of Philadelphia, Pa., some years ago adopted as their standard of steam engine perfection the development of a horse power from the evaporation of thirty pounds of water per hour; and having fully considered and discussed the subject of horse power of steam boilers, they declined to adopt any rule of rating horse power. It would appear quite natural that the boiler should be rated a horse power for each thirty pounds of water evaporated per hour; but as this would bring in the subjects of forced versus natural draught, safety, durability, economy, maintenance, efficiency and kindred subjects, it is quite certain that no rating based upon evaporation could become standard; then, again, there are many boilers in use not connected to steam engines that are furnishing steam for heating, and for re-evaporating, to which the steam engine rating would not apply. Therefore it will appear that while the heating surface rating is the only rating at present recognized, it is the only rating applicable to all conditions under which steam boilers are operated.—*La. Planter.*

A PROFESSIONAL SOCIETY WHICH IS NOT A CLOSE CORPORATION.

ADMISSION to most societies and institutions connected with science and art is becoming more and more a matter of credentials and professional qualifications. Even in the case of those bodies which hold no examinations there must be some direct evidence of professional fitness. This we term raising the professional standard, and to the general public it conveys a sort of idea that the very fact of membership implies a certain amount of guaranteed competency. Just as the uninitiated cannot believe it possible for an R.A. or an A.R.A. to paint a bad picture, so most folks not "in the know" consider a member of this or that learned or professional society to be practically incapable of incompetent work or unprofessional practices. We are not concerned just here to raise any particular question as to how far the public are right in their assumptions in this respect; we simply state the fact. But while in this country, says the *British Architect*, we appear to be using every effort to convert every professional organization, whether of artists or scientists, into close corporations, it may be not uninteresting to note the constitution of the American Institute of Mining Engineers, ably detailed and criticised in the *Engineering and Mining Journal* (New York) by Mr. Rossiter W. Raymond. Mr. Raymond had been asked by the founders of a new association of mining engineers in a distant country for particulars of the plan of the American Institute, which, in view of its signally successful results, they proposed to copy, and it is the substance of a portion of his reply to his correspondents that is given in our contemporary.

The success of the American Institute of Mining Engineers Mr. Raymond considers to be largely due to two features of its organization, viz.: (1) The absence of professional qualifications as requirements of membership; and (2) the absolute control of all its affairs by an elected council, the acts of which are not subject to review, approval or disapproval, by the body of the membership, except so far as the election of members is concerned. Mr. Raymond admits that, by the absence of the requirements of professional qualifications in candidates for membership, certain advantages, such as are possessed by more select societies, are sacrificed, and he by no means seeks to disparage such advantages. But, for all that, he also sees decided advantages in the constitution of the Institute with which he is connected. It is, he says, a voluntary association comprising all who desire to assist its purposes and receive its publications. "We require," he goes on to explain, "no designated amount of professional education or practice. The only requisite for membership is practiced connection, direct or indirect, with mining or metallurgy, and our associates need not have any connection with either. Students not yet graduated are admitted as associates, but made members without question, upon their own request, when they have got into actual practice. The rights and obligations of members and associates are in all respects alike. Both classes can vote, hold office, write papers, etc., and the dues are the same for both.

In fact, the distinction is never felt. We merely require the indorsement by three members or associates of a proposal for membership, in order to have some assurance of the good faith and the respectability of the candidate, and (if he is proposed for member) that he is connected practically in some way with mining or metallurgy. Geologists, chemists, mechanical engineers, etc., are considered to be so connected." The door could hardly be set wider open for all who choose to enter than this, and, at first sight, most prudent folks would doubt the practical wisdom of it.

But the advantages of this free and open system are, according to Mr. Raymond, anything but imaginary. "First," he says, "it secures a large membership: and, consequently, at the moderate rate of ten dollars annual dues, a sufficient income for the publication of valuable papers and volumes, with all necessary engravings. The value of these publications, on the other hand, is what retains the membership. (2) It attracts men of practical knowledge, but without special foregoing education, such as mine captains and the foremen of mines, furnaces, rolling mills, etc. Such persons are apt to shrink from association with graduates of schools, or from subjecting their professional qualifications to review. Yet they are the very men who can be most helpful, if they can be induced to communicate their observation and experience, without the risk of mortification. We have studied from the beginning to get hold of such men. (3) It results in the constitution of our membership to a large extent of young men with reputations to win, instead of young men with reputations (and business interests) to guard. Membership of itself gives no professional standing; but it gives a large and appreciative public, and a chance not easily got in any other way, to win quick recognition for good work. In this way it has often led to the rapid advancement of men who would otherwise have been years in making their merits known. The natural consequence is, that we receive contributions in abundance, and that, although they are of unequal value, the general average is good; and each of our volumes contains as much first class professional matter as that of a society organized upon higher acquirements for membership."

The active control and management of the Institute's affairs are vested absolutely in the council of eighteen members, who are elected by the general body of members, numbering some 2,400, through the post. The Institute never acts as a whole, except in the election of officers and members. At the annual meeting the council presents its reports for the preceding year, but this is done for the information of members only, the report is not discussed or approved, but simply presented and subsequently printed and distributed.

The council being thus omnipotent within its sphere, care has been taken that the council should be subject to steady but not too sweeping changes of membership. The latter end is secured by limitations upon re-election, except as to the offices of secretary and treasurer, in which frequent change would be injurious. The former point is of the highest importance, and is vigilantly guarded, partly by the rules, but still more by the construction placed upon them by numerous precedents. In organizing a new society upon the same plan, Mr. Raymond thinks it would be well to make the rules more explicit even than theirs, so that the question of the competency of the council to do or recommend this or that might never be discussed.

Of course, in a body so extremely liberally constituted, and possessing so autocratic a method of self-government, special precautions had to be taken to insure certain limitation of action, and hence it is that neither the council nor the Institute can do anything outside of the simple business of holding meetings for the reading and discussion of papers and the publication and circulation of such proceedings. For the opinions expressed in the papers or discussions the Institute in no way holds itself responsible, and, in fact, the Institute, neither as a body, nor the council in its name, can express any opinions, by resolution or otherwise. The theory of this is that no member shall be indirectly committed to any official opinion or proposition by the action of a council which he helped to

select for an entirely different purpose, or by the vote of a local gathering of a minority of the members in which he was neither present nor represented. And Mr. Raymond is very emphatic in his approval of an explicit prohibition of all official expressions of opinion on every subject. Thus limited, the complete power of the council can, he urges, do no harm, and the true work of the society will be conducted with the minimum of friction and labor.

The whole good of the Institute is, in fact, made to rest on the practical value of its printed proceedings, and a certain *esprit de corps* generated by the very cosmopolitanism of its membership, together with the social good fellowship (independent of all rules) which is made prominent at the meetings. The success of the scheme adopted by the American Institute of Mining Engineers has, however, only been achieved by accepting fully the principles of construction already enumerated. We are by no means prepared to say this is the best form of constitution for professional institutes generally, but that it has answered remarkably well in the case of the American Institute in question there is no reason to doubt, and for that reason furnishes us with a typical example of a professional society which is not a close corporation.

PITTLER'S UNIVERSAL TOOL.

The interesting universal tool which we illustrate is the invention of Mr. W. Von Pittler, of Leipzig-Gohlis, and is described as follows in *Engineering*, to which paper we are also indebted for our engravings. Essentially the tool is a lathe, and for the usual class of lathe work it is claimed to be even more efficient than the ordinary lathe, while owing to its special construction work can be done on it that the ordinary lathe cannot touch. The general appearance of the machine is shown in Fig. 1, while Figs. 2 to 5 show details. Its controlling feature is the shape of its bed and the form of saddle adopted, which is, perhaps, more clearly shown in Figs. 8 to 10. In section the bed is a truncated triangle, and the leading screw is placed underneath it, so as to be completely protected from turnings, etc., falling on it. The saddle completely surrounds the bed, and is circular in form. On it is a split ring, carrying the slide rest, which from the circular form of the saddle can be rotated quite round the bed if desired, but can be clamped firmly in any position required, by means of a clamping screw as shown in the engravings. The method in which the slide rest is fixed to the carrier ring should also be noticed. It is attached near its front end by means of a spindle passing through a hole in the carrier ring, and hence it can be rotated round the axis of this hole if desired, a clamping screw being used to fix it in place at any required angle. Summing up, it will be seen that the tool has four possible movements, any or all of which can be made automatic: (1) The ordinary traverse along the bed effected by a leading screw, (2) a revolving motion round the bed, (3) a revolving motion round an axis at right angles to the bed, and (4) the ordinary fed-in and fed-out motion of the tool. The full advantages of these various motions can only be appreciated by examining some specimens of the work done in the machine, as illustrated in the engravings. In Fig. 1 the machine is at work in turning up the circumference of a hand wheel to a truly circular form, the action being entirely automatic. The wheel is driven by a dog as usual, and the slide rest is set in the position shown. A worm wheel is fitted to the bottom of the slide rest spindle, and causes the slide above it to perform motion (3), viz., rotation about an axis perpendicular to that of the bed. The tool is thus given the proper motion to make the rim of the wheel circular in section. The worm wheel is driven by means of a telescopic shaft having Hooke joints at each end as shown, the first motion being obtained from a worm on the end of the lathe spindle gearing into a second worm. A trigger is fitted to the worm motion in the slide rest spindle, which automatically stops the feed when the tool has worked round the rim, before it commences to cut into the arms of the wheel. In plain cylindrical turning, motion (2), viz., rotation round the bed, is used to avoid any necessity for packing up the tool; by using this motion and feeding the tool in or out as required, the tool can always be made to meet the work at a suitable angle, and thus time is saved. The automatic feed motions fitted are very complex. As already mentioned, the lathe spindle carries a worm at its back end, which worm can be changed for one of more or less threads as required. Moreover, as shown in Fig. 5, a second worm driven by the lathe spindle at twice its own speed is provided alongside the first, and the worm wheel which forms the connection to the automatic feeds can be swung round to gear with either of these as desired, thus giving instantaneously a reduction of the feed to one-half, or *vice versa*. On the spindle carrying this worm wheel are, as shown in Fig. 3, two bevel wheels, either of which may be made to gear with a bevel wheel on the leading screw of the lathe. When it is desired to drive an automatic feed on the slide rest the lathe is arranged so that this bevel wheel can be cut loose from the leading screw and made to drive a spur wheel, which, gearing into a second at the front of the lathe, drives the telescopic shaft, shown in Fig. 1, through the Hooke joint already mentioned. This arrangement is not, however, shown in the sectional views. Screw cutting is very easily performed in these lathes. Owing to the device of having two worms at the tail end of the lathe, as shown in Fig. 5, any worm wheel can be used to cut two pitches, one twice as great as the other. Moreover, to cut any pitch one wheel only is required, and the entire stock of change wheels necessary for ordinary threads is shown under the lathe in Fig. 1. As showing an additional use of motion (2), viz., rotation round the axis of the lathe, we may refer to Figs. 12 and 13. Fig. 13 represents the section of a tap as turned up in this lathe. It is completed, screw thread and all, to the section shown, the thread being cut full depth all the way round the three-cornered figure, and the grooves are then cut out in a separate machine as usual. This is done by causing the tool to swing in or out by rotating slightly backward or forward round the bed. The carrier-ring is unclamped and the motion obtained by the use of a suitable cam or former. The milling cutter shown in Fig. 12 is also made this way. A flat tool cut to correspond with the shape of the cutter rim is

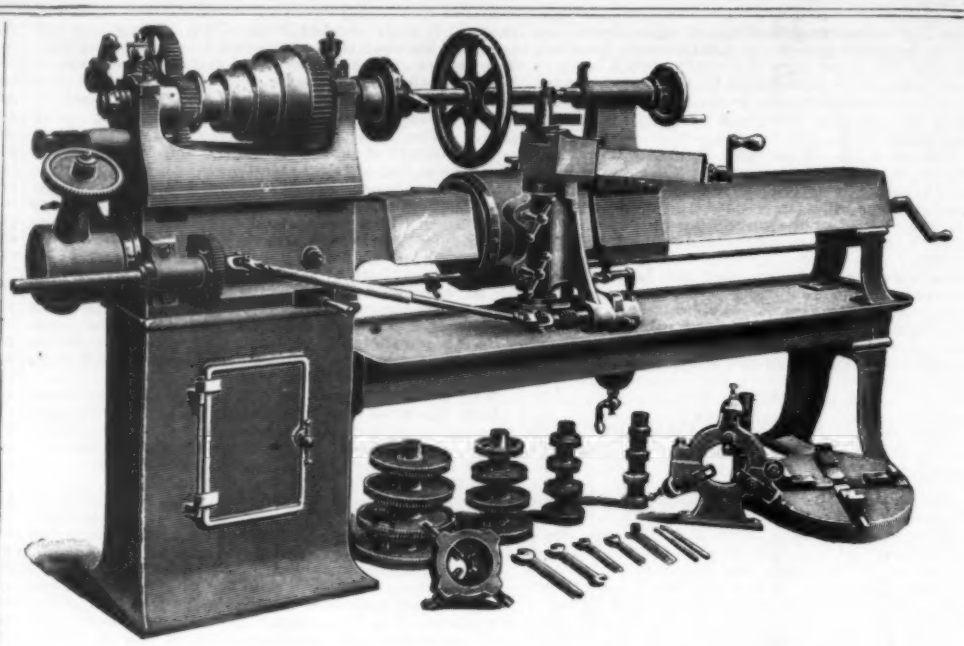
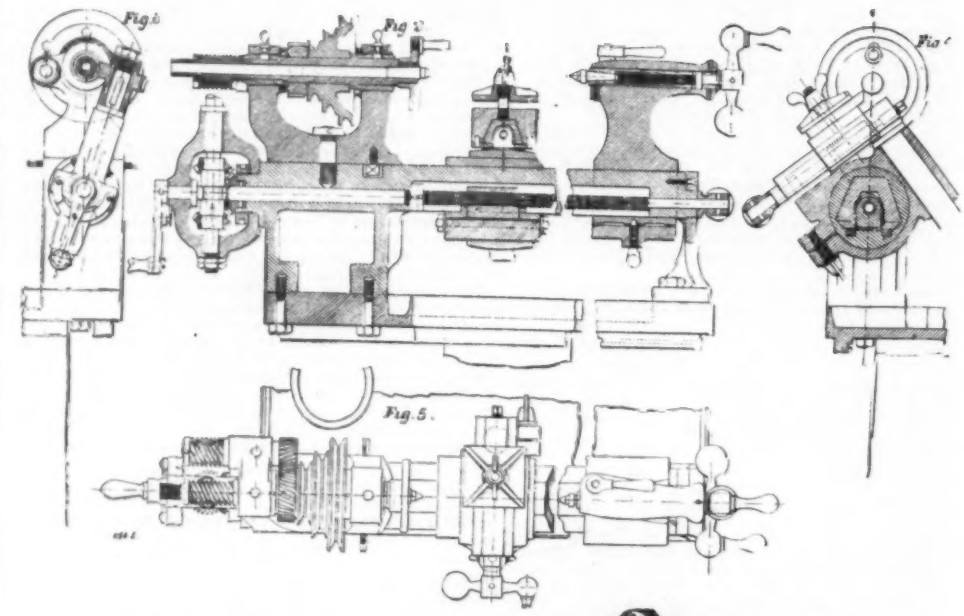


Fig. 1.



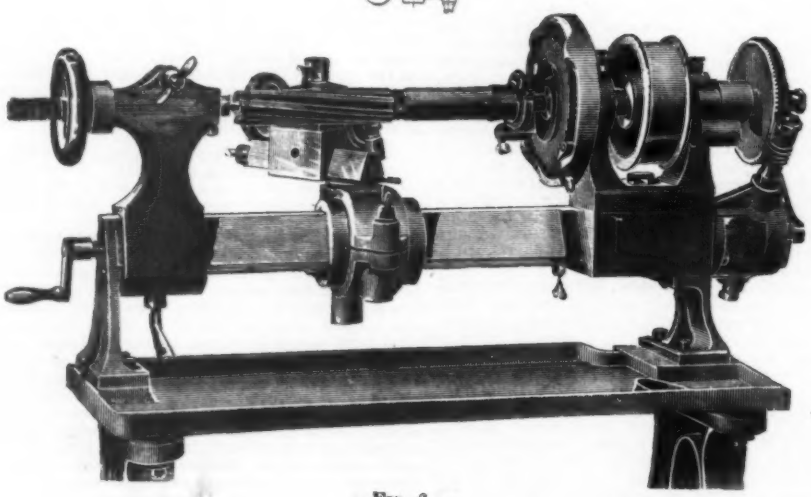


Fig. 6.

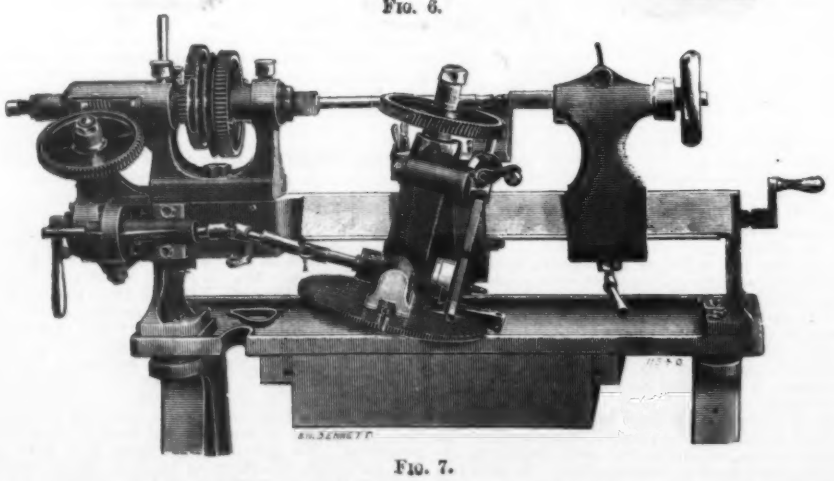


Fig. 7.

PITTLER'S UNIVERSAL TOOL.

used, and fed in and out as explained above. This class of work is said to be done remarkably cheap.

Another interesting example of the work of the machine is shown in Fig. 14. This represents a sphere with the screw thread cut on it, which screws into a hemisphere as shown. The whole of the work was done automatically, and though only a mechanical curiosity, well illustrates the capabilities of the machine. The process of turning up the sphere, preliminary to screw cutting, is shown in Fig. 10. Where revolving cutters are used the machine can turn out an immense variety of work. Thus in Fig. 6 it is shown at work on a spiral reamer. In this case it will be noted that the worm and worm wheel at the end of the lathe have been interchanged, the latter being placed on the lathe spindle and the former being connected to the leading screw. In Fig. 7 the machine is engaged in cutting a worm wheel, the operation being entirely automatic, the wheel being fed round tooth by tooth, as each is completed by means of a ratchet and wheel below the bed as shown. In Figs. 8 and 9 more wheel cutting is shown, while Fig. 11 shows another mechanical curiosity turned out of the machine when using revolving cutters. It is impossible for us in the limited space at our disposal to describe one tithe of the ingenious automatic fittings Herr von Pittler has provided for his machine, but those interested in automatic tools will find a treat in store for them if they pay a visit to 55 Farringdon Street, London, where about forty of the machines are now set up. The machines are built in all sizes up to the very heaviest by the Deutsche Werkzeug Maschinenfabrik, Chemnitz, Germany, and are also being manufactured in France and Belgium.

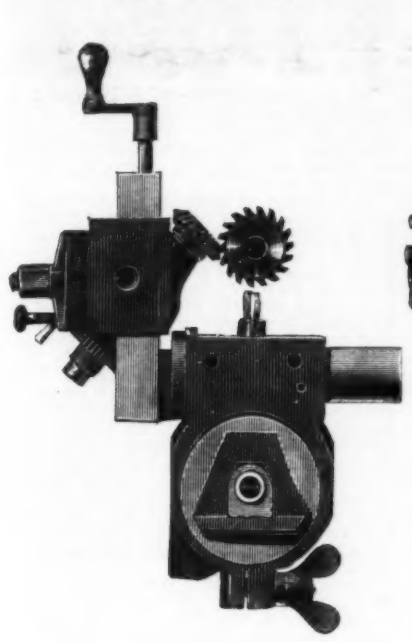


FIG. 8.

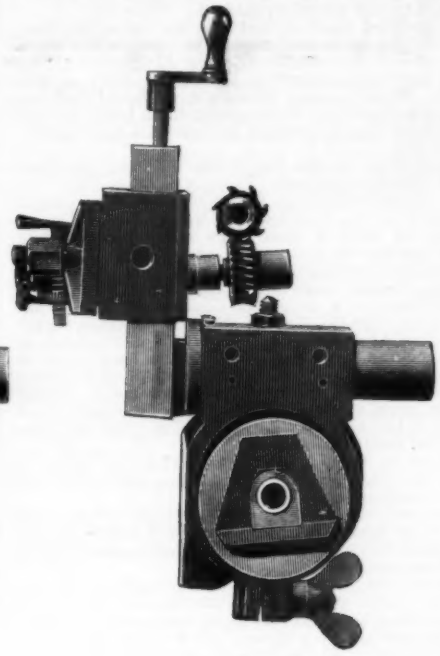


FIG. 9.

FIG. 10.

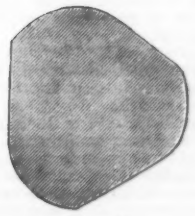


FIG. 13.

FIG. 11.

FIG. 12.

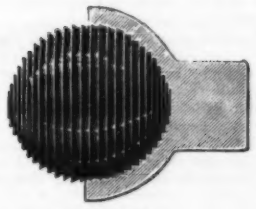


FIG. 14.

PITTLER'S UNIVERSAL TOOL.

A LARGE FLOATING CRANE.

WHAT our modest American cousins claim to be the largest floating crane ever built is now in complete order and running successfully at Messrs. Cramps' shipbuilding yard, Philadelphia. Not long ago it lifted a 70 ton boiler off the dock, towed itself a distance of 150 feet, and lowered its load into the cruiser New York in less than twenty-five minutes. Only two men were required to operate the machine; and the ease with which the 70 ton boiler was lifted from one place to another suggested play rather than mechanical engineering of a high grade. It is utilized for placing the armor plate machinery and boilers on the new United States cruisers which are being built by that firm. It is a peculiarly shaped instrument. A large vertical mast projects upward from a conical steel framework, which rests on the floating pontoon. The conical framework is inclosed with wood, and inside the house thus formed are four engines of 40 horse power each, controlling the drums for the pulley cables and the machinery for turning the arms around and propelling the lifting pulleys toward the outer end of the main boom. The height of the cone is 65 feet. The mast is 51 feet high above the boom. It is of steel, and hollow, being 3 feet in diameter, and braced here and there inside with extra thicknesses of metal. It rests in a socket on ball bearings, consisting of 42 steel balls, each 4 inches in diameter, and absolutely true. Another set of balls is used at the cap of the cone for lateral pressure as the arms swing around. From three stay plates that hook themselves over the top of the mast strong guy cables stretch to the lifting arm to prevent it from breaking. The arm with which the lifting is done is 65 feet long, and the other has a length of 50 feet. The arms are made of built-up steel of the toughest quality. The longer one is fitted with traveling machinery, so that it may deposit its burden at any required distance within its range away from the mast. The short arm is anchored to the foot of the cone by strong cables, and when a very heavy burden is lifted, two long steel arms are dropped from the outer end to the side of the pontoon below. The contrivance is certainly ingenious. The pontoon on which the derrick rests is of iron and fitted with a system of water compartments. It is 13 feet deep, 69 feet long, and 62 feet wide. When a boiler or any heavy weight is to be hoisted, the water is let in on the opposite side of the pontoon in order to keep the derrick on an even keel. As the burden travels toward the outward end of the lifting arm more water is admitted, and before any lowering begins the machine is carefully adjusted and made level. The derrick is fitted with pumping machinery so that when its burden is left in place the water is pumped out. In admitting the water no pump is used. It is allowed to run right in from the river. The derrick is operated by the engineer in the third story. By means of capstans on the pontoon it can tow itself about the shipyard. The pump, I may say, is fitted up with all the essentials for extinguishing fires, and it will, no doubt, prove a very effective auxiliary to the fire department of the yard. The water ballast tanks, three series of five each, are heavily ballasted with cement, of which material nearly 60 tons are used. Each of the twenty compartments which constitute the hull is entered from the deck through separate manholes or hatches. —*Transport.*

LIQUID FUEL FOR STEAM MAKING.

By F. R. HUTTON, C.E., Ph.D.

THE combustibles which are at the service of the engineer for industrial purposes come to his hands in three forms. The solid fuels are coal and wood, lignite and peat, in their natural or derivative forms; the liquid fuels are petroleum in its crude state or as a product of refining or distillation; and the gaseous fuels are either natural or artificial fuel gas. The solid fuels are historically the first; the liquid and the gaseous have only come to the industrial importance which they now occupy during the last thirty years.

The combustion of a fuel being a union with oxygen, which is a gas, it is necessary that the fuel, whatever its form, be first reduced to such a fine state of division that it shall be possible for the union to take place rapidly. For the solid fuels there is necessary a certain consumption of energy in the form of heat in bringing about this fine division, either by a process analogous to distillation, by which gas is made, which subsequently unites with oxygen, or else by union with oxygen only on the surface of the solid particles of fuel. In the latter case, from the relative slowness of the combination, the temperature of the flaming furnace is kept at a lower point than where the form and fine state of division of the fuel permit this chemical union at a more rapid rate.

Confining attention to the subject of fuels in a liquid form, it may be stated that the first experiment in this country upon any considerable scale seems to have been made at the Morgan Iron Works, in New York City, in 1865, and is identified with the names of Colonels Foote and Julius W. Adams. The very high price of coal at that time, and the recent large discoveries of petroleum, gave special interest to this series of experiments, although the previous investigations by Professor R. A. Fisher, of New Haven, had shown that the question of the substitution of oil for coal as a fuel was largely if not solely an economic question affected by the relative cost of the two materials and their accessibility in any locality.

The English experiments of the same period bear date of 1864, under the system of Mr. C. J. Richardson. These were specially stimulated by the marine interests, with a view to the advantages offered by oil as a fuel on board ship for strategic and practical reasons, and secondly, by reason of the special problems facing engineers in the colonies, where coal was difficult to obtain for locomotive purposes, and where, in the dry season, it was of prime importance that no spark should be discharged from a locomotive stack to ignite a parched and inflammable vegetation.

In the development of the use of oil as fuel three great classes of furnaces have been put forward. That class in which the oil is introduced to the fire box in a liquid form embraces four types. The first is that in which the oil is delivered into pans in the fire area, where it is set fire to with the access of what air can be got to it—a method obviously imperfect, uneconomical and accompanied with great waste in the form of smoke. In the second form the oil is delivered into grooves upon a step grate so that it overflows from step to step, meeting the air supply between levels. This secures a much better union with the air and seems to work well, particularly in metallurgical practice. The third type may be called drop furnaces, where the oil drips from a number of pipes on to the combustion area, and is there ignited. The fourth type introduces the oil as a fluid up from below through a porous bed of lime or other similar material, at the top of which it meets the air for combustion, and burns as from a wick. This is one of the most satisfactory methods of using the oil as an undivided liquid, but it presents the difficulty that perfect combustion cannot be insured for any great length of time. The heavy constituents of the oil accumulate in the porous layers and gradually interfere with the flow.

The second great system for the combustion of oils involves the principle of finely dividing the oil by means of a jet of air or steam moving at high velocity and forcing the oil in spray form into the fire box. The burner in all systems of this class is practically an injector, and the steam or air carries the fluid with it usually in an annular jet, and its fine state of division brings it to a condition in which it can combine rapidly and completely with the air necessary for combustion. It will be seen that in this system a subsidiary apparatus must be depended on when the fire is first to be started. There must be a pressure of steam either in the boiler which is being fired or in some other boiler, in order that the steam jet can be started, or else the fire must be started with solid fuel, and the use of oil begun only when the necessary pressure has been accumulated.

Where air is used to bring in the oil, a pump is required to produce the necessary pressure, and for this reason the plan of using steam as the inducing medium is practically the only one which can be used in locomotive service whereby subsidiary apparatus must be reduced to its lowest terms. As to the relative advantages of air and steam, when they are equally available, steam would appear to have the advantage over air, in that it is at a higher temperature than air usually is when it enters the nozzle of the burner, and that it does not entrain with it inert matter, such as nitrogen, which has to be heated up by the flame, but does no useful service in the combustion. Moreover, if the temperature of the flame is high enough to dissociate the oxygen and hydrogen which formed the steam, while the heat absorbed in this dissociation is the same as that given out in the combustion of the hydrogen of the steam, the mechanical effect is to increase the proportion of the hydrogen in the flaming mass and thereby to increase the length of the flame, with a consequent gain in its radiating effect. While

there is no gain in units of heat, there may be a gain in the efficiency of the flaming mass to transfer its heat to the water in the boiler. On the other hand, there is required for the combustion a certain weight of air, and its introduction with the oil in the jet secures an intimate mixture of this air with the oil favorable to its union with it in combustion, and the specific heat of air is 0·23, while that of steam is 0·48, so that more heat is required to bring the vapor of water up to the temperature of the products of combustion than is required to bring air to the same temperature.

The fact, however, that the steam system requires no air pump will be a preponderating argument in its favor in many places. For the heating of forges also, the steam would appear to be an inconvenient diluent of the flaming mass.

It would be impossible here to allude in detail to the various forms of burner which have been presented for the use of oil as fuel. There are several features, however, which a good burner must have in order to work satisfactorily. The great difficulty in any form which has its nozzle near enough to the flame to have combustion begin at the very orifice is that the oil will carbonize at the orifice and gradually stop it up, sometimes checking it altogether. The burner must be of such construction that these pasty or hardened accumulations may be easily removed without stopping the apparatus, or else the burner must be fitted in duplicate, so that the one can be used while the other is being cleaned.

The best known injector of this class is that brought out by Mr. Thomas Urquhart, locomotive superintendent of the Grazi-Tsaritzin railway in southeastern Russia. His arrangement is a steam system, and the nozzle for the injector for oil enters within, but does not pass through, a thimble inserted in the rear water leg of the locomotive boiler. The flame does not reach the nozzle of the injector, and the trouble from carbonization or cooking of the oil particles is largely eliminated. If this should occur, or if the annular oil channel should become clogged by any matters in the oil, the steam tube can be retracted by a screw motion operated from the foot-plate of the engine, and the steam jet, which is one of the most detergent elements known in the arts, will immediately blow the opening free and clear.

In any of the comminuting systems of this class care must be taken that the flaming particles of oil coming into the fire box at high velocity from the jet should not impinge upon a particular spot of the heating surface. In all the systems it is aimed to secure this end by interposing in the path of the jet a baffle plate of fire brick or similar material. In the Urquhart furnace the fire brick is built up at the front end of the fire box nearly to the height of the lower row of tubes, and an arch is sprung across from side to side of the fire box, very much in the position in which the usual arch is found in bituminous fire boxes, and it is in this blind, rampant archway that the intensity of the combustion takes place. This mass of fire brick becomes white hot, and serves not only to store and radiate heat, but also to ignite the jet when it is cut off for a stop of the train. An objection to all burners of this class is the noise which they make, but in many places this need not be more objectionable than the noises in many fire rooms from quenching the ashes by turning a hose jet upon them. It is comparatively easy to prevent annoyance from explosive ignitions of the oil, if the precaution is taken to put into the fire box a lighted wad of waste shavings, and after this to turn on first the steam, and then the oil, to the burner. Where the fire chamber can be come filled with vapor of oil before the flame is applied, there may be enough carbon ready to combine instantly with oxygen when the flame is applied to cause an explosion, which is always startling and may be dangerous.

The third great system of furnaces for burning oil embraces those in which the oil is first made into gas and is burned in the fire box in true gaseous form. This principle was applied in oil firing in this country as early as 1867, when a furnace of this sort, devised by Colonel Foote, was tried in the United States gunboat Palos. A flat coil of pipe conveying the oil to a larger pipe occupying the place of the bridge wall was brought up to a high heat by the combustion of the oil delivered in burners underneath the coil and in front of the retort. Superheated steam similarly heated by the issuing flame from the burners brought the whole mixture up to a very high temperature, and the products burned as a gas. In this case, of course, the gas and steam streamed out of the burners at a high velocity.

The Archer fuel process is essentially similar in principle, forcing the oil by a pump through a circular coil of pipe, which is kept at a high temperature by an annular fire surrounding the central retort, which, in this system, is called the "thermogen." Steam, in a similar coil, is superheated, enters the thermogen with the gasified oil and passes with it through the necessary regulating valve to the furnace of the boiler under which it is to be used. Unlike the vapor system already mentioned, it enters the furnace at a comparatively low velocity, without the rush and roar characteristic of so many of the other systems, and it is claimed not only that this peculiarity results in the consumption of less oil for a given amount of evaporation, but also that there is avoided the difficulty present in some of the comminuting systems of the formation on the heating surface of an incrustation due to the constituents of the oil which are not thoroughly burned in the fire box, but are carried forward to be deposited upon the cooler metallic surfaces. The difficulties of the gas system would appear to be those attaching themselves to the use of a retort which either could become clogged from residual matter in the oil or which would deteriorate from the action of the flame and from expansion at high temperatures.

The advantages which can be urged in favor of the use of liquid fuel are many and important. First, the crude petroleum has a higher calorific power than most of the coals, weight for weight. Where a crude oil can be used from which certain of the burning compounds have not been removed by refining, it is possible to secure a calorific power of 21,000 heat units, while the calorific power of coal may be put at from 12,000 to 13,000 heat units. This means that one pound of oil is equivalent to 1·6 pounds of coal. It is often called 1¾. English experimenters, using a lower calorific power of coal, have obtained results correspondingly more advantageous for oil. This consideration has a very important bearing in both locomotive and marine service. In the locomotive tender it is possible to diminish the amount of fuel which must be carried between terminals to keep up a given speed or hauling power. The dead load is diminished with consequent obvious gain But more important still, if there can be burned over a given grate area a fuel of higher calorific power, it becomes possible to make more speed from a given boiler in a given time, which means that the cylinder capacity can be increased without transgressing the limits of volume of boiler surface of grate which the conditions of practice in respect to gauge and curvature impose upon the designer of such machinery. In marine practice, not only is the ship lightened or the possible length between fueling stations increased, but, by a parity of reasoning, a smaller bulk of boilers can be expected to do a given amount of work.

Outside this fundamental and far-reaching advantage of a high grade liquid fuel, there are many practical advantages which need only to be enumerated to convince any one of the great convenience which is permitted by the use of liquid fuel. These are:

1. Diminished waste of fuel from the loss of combustible with the ashes and gases. In locomotives there is a loss of fuel through the stack, rated usually at from 10 to 20 per cent., according to the intensity of the draught. This is saved in the use of liquid fuel, besides which there will be no sparks to be taken care of in the smoke box, if arrested, or to set fire to property, if blown out.

2. A reduction in the cost of the labor for handling the fuel, which is twofold. There is in most plants an expense for handling coal into bunkers, and a second handling from the bunkers into the fire box. The oil handling for both of these steps is mechanical, while with the solid fuels the second step is but rarely so. It is possible, therefore, for one man with oil fuel to take care of many more boilers than with solid fuel.

3. In cities it is a matter of convenience and economy not to provide for the disposal of ashes, which from the solid fuels amount to from 200 to 300 pounds or more to the ton, and, where the plant is large, have to be provided for by special contract outside of the usual facilities offered by the municipal government. There is no flue dust to clog fire tubes and diminish their efficiency; but this may sometimes be offset by a deposit of oil residuals in them.

4. Where no firing tools are required, less injury is done to the brickwork of the fire boxes, and grate bars do not deteriorate.

5. Repairs to the brickwork of the ash pit and the boiler room floors are diminished, as the tendency to crack when heated by hot cinders and quenched by water is absent.

6. Better regulation of the fire is possible, as the demand for steam may vary. This diminishes losses of heat from blowing off at the safety valve, which doubtless often amounts to a loss of 5 per cent. or over.

7. The opening of the furnace doors for firing and cleaning is made unnecessary, so that the boiler may be expected to suffer less from unequal expansion and contraction.

8. Where the engine room is also the boiler room, the absence of dust and ashes about the machinery is of manifest advantage.

9. The absence of sulphur is favorable to the life of the boiler plate, and this is especially an advantage where there is moisture in the solid fuel, which permits the formation of an active sulphurous acid, corrosive in its character.

10. The labor of the fireman is made much more agreeable, inasmuch as all the work of cleaning and the strain of standing in front of open furnace doors are done away with.

11. Aboard ship, on the locomotive, and in cities, it is easier to secure a combustion as nearly smokeless as a due regard for economy will permit. For war purposes smokelessness is a matter of considerable moment, inasmuch as a trailing banner of soft coal smoke will betray the presence of a steamer otherwise invisible below the horizon. In the locomotive there are no cinders to annoy the travelers or the train crews.

12. In the contracted fire rooms of vessels the temperature of the room can be kept lower, and in tropical latitudes the lot of the firemen will be very materially mitigated for this reason, as well as by diminishing the severity of their labor.

13. On shipboard liquid fuel can be stowed in places where solid fuel could not be put.

The disadvantages attached to the use of liquid fuel will differ according to the nature of the oil employed. In this country two forms of oil are presented for fuel use. One is the product of the oil wells in Pennsylvania and Ohio—the crude petroleum as it flows from their mouth, sometimes more specifically designated as Lima oil, from the town of that name. In certain cities the limitations imposed by health boards and fire departments preclude the use of this material, and their reasons constitute two objections to be urged against the great bulk of available crude petroleum. The first of these objections is its inflammability or high flashing point. This means that because of the presence in the oil of light components which distill off in the form of vapor spontaneously, or under agitation, or at very low heats, there will be given off a light hydrocarbon vapor which will form with air a mixture that will ignite explosively when an open flame is brought anywhere near it. This peculiarity has a very important bearing upon the use of crude oil on board ship, where it would be kept in confined spaces, or in the locomotive, where naked flames are likely to be found around the oil tank. The second great difficulty with crude oil is its offensive smell, which has a very important effect in limiting its use.

The other form of oil used for fuel is the product of the refining process after the elimination of the naphthas and the kerosene or burning oils from the crude material, which leaves behind about 60 per cent. of the original quantity, having a specific gravity averaging 40° Baume, and a flashing point above the boiling point of water. This obviously is a very much safer form of oil for fuel and is not objected to by fire and insurance corporations, provided only that certain conditions looking toward the safety of the premises in case of accident are complied with. The usual requirements are that the storage tanks should be of iron with tight covers provided with ventilating pipes and overflows; that the tanks if possible should be underground, and the piping also; and that the main tank, of larger capacity than the distribution tank, from which the oil passes to the burners, should be, if above ground, surrounded with a dike or embankment, inclosing a space large enough to hold the entire contents of the tank.

Oil of this class, having no volatile material remaining, gives off little or no odor, but there has been sacrificed not a little of its calorific power and of its length of flame. It will contain 85 per cent. of fixed carbon and upward of 13 per cent. of hydrogen in the ordinary run of samples, the balance being oxygen and impurities, so that it will compare in composition with coal of the bituminous class so much used for steam purposes, and will have by no means so much higher a theoretical calorific advantage over the solid fuels.

The disadvantages common to both forms of oil fuel are, where the vapor system is followed, the noise made by the burner, and, in the gaseous system, the sacrifice of part of the fuel efficiency for the distillation of the gas, and in both the air vapor and the gaseous system the necessity for auxiliary and additional apparatus, with their first and running cost.

It should be kept in mind that the production of coal is much in excess of the present production of oil.

But the final and conclusive argument is the commercial one, as to the relative cost of an equal weight of calorific efficiency in solid and liquid fuels. This calculation may be made to seek the answer in either equivalent price per ton of coal or equivalent price per barrel for oil.

The product of multiplying the weight of oil per gallon in pounds by the number of gallons in a barrel is the number of pounds of oil in a barrel. If this product be multiplied by the ratio in heating effect of one pound of coal to the pound of oil whose calorific power is known, we have a product which can be handled in comparison with the weight of solid fuel in a ton. If we divide the number of pounds in a ton by the product first obtained, and multiply the result by the price of oil per barrel, we get a figure showing what coal must cost per ton in order to be of the same cheapness. On the other hand, if we divide the above product by 2,000 or 2,240 and multiply the result by the price of coal per ton, we obtain the equivalent price per barrel which oil must cost if it is to be no more expensive than solid fuel. The cost of coal in this second calculation must include the labor and expense of handling the coal and ashes, which will be dispensed with where oil is the fuel, and the price of oil per barrel in the first calculation must similarly be taken as delivered to the consumer and not at its price at the wells.

A calculation made in 1889 by Mr. H. F. J. Porter for the use of oil under the boilers of an extensive steam plant in New York City showed that at the prices then prevailing for fuel oil of the quality at that time obtaining, 6·7 barrels of oil were equal to a gross ton of coal, and that with the conditions of the plant in question it would be possible to pay $3.17 per long ton of coal, or that the equivalent price of oil was three mills per pound. Readers of this magazine will have noticed that in the department of mechanics, for August, 1892, it was stated that oil at 2·4 cents would compete with coal at $3.95 per ton, but where coal was $3.10 per ton and oil at 2·25 cents per gallon, the coal was cheaper. Where the price of coal drops to the neighborhood of $1 to $1.50, oil even at 1·5 cents per gallon is much more costly. An interesting table of comparative values computed by the above method was presented in the lecture by Dr. Dudley above referred to, and will be found in volume xcvi. of the *Journal of the Franklin Institute.—Engineering Magazine.*

ASBESTINE.

THE loadings, by which we mean those substances employed for increasing the weight or density of paper, and imparting certain characteristics to it, are diverse in their properties. The greater number of them lay claim to special characteristics in themselves, and naturally enough, when used, exert a corresponding influence on the paper produced. Thus china clay, the most universally used loading in the paper industry in England, is characterized by its soft and soapy nature, and imparts these properties to the paper in a greater or less degree in accordance with the proportion used. Papers highly charged with it are soft and absorbent. Hence this loading has been found to be specially adapted for producing type-printed papers. The ink on such papers is rapidly absorbed and dries almost immediately, the importance of which, in these days of quick-running printing machines, cannot be overestimated. Were it otherwise, the printed page would be badly smeared. Another peculiarity of this loading, second to its soft and soapy nature, is its adhesive properties. Notwithstanding china clay is always in a very fine state of division, and is so thoroughly miscible with water that it subsides only after long standing, it adheres with ready tenacity to the fibers forming the sheet of paper. This is particularly observed after the sheet of paper has been dried; and is, no doubt, due to the fact that the clay does not readily lose its water of combination, the presence of which maintains its absorbing power. When papers highly charged with china clay are damped or wetted with water for the printing machine, the clammy nature of the loading causes it to adhere firmly to the fibers, and there is little dust formed, to which the printer so strenuously objects because it stops up the type.

Indeed, the chief essential properties of a good loading consist in (1) its degree of fineness; (2) its flocculent nature when mixed with water; and (3) its power to adhere firmly to the fiber. It is obvious that these three properties are dependent, in a measure, upon one another.

Asbestine, of which we wish to speak more particularly in this article, has been but recently offered to paper makers as a loading material. As many of our readers are aware, it is a species of asbestos rock found in extensive deposits in Austria and in other parts of Europe. In Austria it occurs in large quantities of more or less purity in the Carpathian Mountains, and is mined along with the mineral asbestos, with which,

as the name implies, it is very closely allied in composition and nature. In fact, the difference in composition is so slight that it may be considered as substantially the same mineral, existing, however, in a different form. The lumps from the mine are selected as to color, etc., the crystalline, somewhat transparent, and not too deeply colored pieces being laid aside and ground to an impalpable powder. In this state it presents a very different appearance to what it was in the lump. It grinds to a pure white powder—the combined effect of its original peculiar hue and its now very fine state of division.

Under the microscope this powder presents a different appearance to china clay. It is more crystalline, is heavier, its specific gravity being greater, but is opaque. It does not, however, appear to be so highly fibrous as it claims to be. Of its adhesive properties, it is somewhat difficult to judge, but, owing to the ragged nature of the surfaces of the particles, it may be accepted that it possesses this in a fair degree.

Asbestine is perfectly anhydrous, possessing no water of combination, and only minute quantities of hygroscopic water. In this respect it differs widely from china clay, as mentioned above, and, therefore, in those papers highly charged with it, unless means are adopted to thoroughly incorporate it within the texture of the web, it tends to fly off in the form of dust, while the paper is passing through the printing machine. The absence of hygroscopic water has, however, certain advantages, principally in the direction of the yield. In this matter, it is a more economical loading than either china clay or pearl hardening, both of which contain varying quantities of hygroscopic moisture. Unlike the former of these, however, it does not become so plastic when wetted with water, being of a more granular nature. In this respect, a good sample lies midway between pearl hardening and china clay. The yield from asbestine is more uniform than is the case with either of these other loadings, mainly because it is comparatively much drier in the state it is delivered to the mills, and being, as a general rule, purer, can be used direct in the beater without preliminary preparation. The ragged surfaces of the particles cause it to cling tenaciously to the fiber—a circumstance greatly assisted by the glutinizing nature of the resin size. As a general rule a yield of from 70 to 85 per cent. is obtained with ordinary care in papers containing average quantities of mineral matter.

In America, asbestine is extensively used, as it is found in large quantities in that country. It is so perfectly white in appearance that it communicates a high degree of whiteness to the pulp with which it is mixed. This is due simply to its purity of color, a property common to other loadings of equal whiteness, *e. g.*, pearl hardening. Papers containing it, when subjected to great pressure or to friction, are highly glazed, and, owing to its non-hygroscopic properties, the gloss on the paper is more lasting than with many other loadings. The highly glazed surface of many printed journals in the United States is obtained by the use of asbestine or closely allied substances. In point of price it is, weight for weight, dearer than china clay, but it yields better and produces, under special treatment, effects in color and finish which, in many instances, compensate for its relatively higher value.—*Chemical Trade Journal.*

THE MANUFACTURE OF LIQUORS AND PRESERVES.*

By J. DE BREVANS, Chief Chemist of the Municipal Laboratory of Paris.

PART III.—PRESERVES.

CHAPTER I.

Brandied Fruits.

BRANDIED fruits are the most important preserves that the liquor manufacturer is called upon to prepare, and their manufacture is now a large industry. To obtain good results the most minute care should be used.

Choice and Preparation of the Fruit.—Fruits which are to be preserved in brandy must be sound and plump. They should be gathered before they are entirely ripe and on no account should any decayed or bruised fruit be used. Dust the fruit carefully with a linen cloth, especially if the fruit has a down, as a peach. This done, the fruit is pricked in several places, so that the alcohol can reach the center. The fruit is then thrown in a tub of cold water, as cold as possible, to render the fruit firm.

Whitening or Bleaching.—This operation has for its end the removal of a part of the acrid taste. It is done by plunging the fruit in a vessel of water heated to about 95°. The vessel is removed from the fire for ten minutes, when it is reheated until the fruit begins to float over the surface of the water. At this moment the fruit is removed and thrown into cold water. The whitening is done very rapidly, and is safe if proper care is used.

The fruit being completely cold, is drained on a horse hair sieve. The fruit is now placed in the brandy, that which marks 53° to 58° being used, according to the kind of fruit, the strongest being used for those fruits which contain the most water. After remaining six days in alcohol, the process of sweetening can begin. The fruit is disposed with care in a glass vessel and is covered with brandy in which the fruit has been macerated, after having added 125 to 150 grm. of sugar per liter. Brandied fruits require to have the sugar added as a measure of precaution to preserve their firmness and their color. The jars are hermetically sealed and exposed to a moderate temperature and away from the light.

Apricots.
Abricots.

The apricot (*Prunus armeniaca*, L.) was originally a native of the Orient and was introduced into Europe by the Romans in the time of Pliny. There are a number of varieties of the apricot. Some which are grown on trellises produce the earliest fruit as well as fruit remarkable for its size, but those which are used by the liquor manufacturer are less regular in form and color, but have a more agreeable taste. Apricots which have a fine odor should be chosen, and they are prepared for consumption in the following manner: Take apricots of a clear yellow, without being entirely ripe, beat with a cloth to remove the down, and pierce. Detach or loosen the stone from the fruit without removing it. Puncture the place where the stem was removed with a needle and throw into very cold water. Heat the water to 95° in a bright copper basin to whiten them. Remove from the fire for fifteen minutes, then heat anew until the fruit rises to the surface, when it is removed gently with a skimmer and put in a bucket containing very cold water. When the apricots are whitened and cold they are strained and placed on a sieve, and after draining are placed in a vessel containing white brandy at 56°. After six days of maceration the apricots can be sweetened and then they are placed in glass jars or vessels filled with a liquid composed of

Essence of apricot kernels	0 2 l.	
Alcohol (85°)	2	l. 800 c. c.
Sugar	2	k. 500 grm.
Water	5	l. 300 c. c.

Product, 10 l. of fine fruit juice.

To obtain the ordinary juice of fruits the following should be used:

Essence of apricot kernels	0·2 l.	
Alcohol (85°)	2	l. 400 c. c.
Sugar	1	k. 275 grm.
Water	6	l. 500 c. c.

Pineapple.

The pineapple (*Ananassa vulgaris*, L.) is a fruit of the tropics, but can also be cultivated in hothouses. This forced culture has reached great development in France, Belgium, Holland and England. India, South America and the warm parts of North America and Oceanica consume vast quantities of pineapples and the fruit has acquired great commercial importance. Factories for preserving pineapples are in operation in India, Singapore, the Antilles, particularly in Martinique.

The Appert system is largely used. In the French colonies M. De Lavesan has successfully cultivated a number of varieties, including the common, pineapples without prickles, a pyramidal variety and a kind which produces mammoth fruit. The pulp of the pineapple and its juice produces a strong alcoholic liquor, which is largely consumed in warm countries. On the Congo a brandy is extracted from which a very pleasant liquor is prepared.

Brandied pineapple is prepared the same as oranges, lemons or angelica. The fruit is either left entire or cut in pieces.

Angelica.
Angélique.

Brandied angelica is prepared from the beautiful glassy stem, which is cut in pieces three or four inches long. Its further treatment is the same as for oranges.

Citron.
Cédrat.

The citron (*Citrus medici*) is a fruit of an ovoid form, with a thick skin, the color being a clear yellow. The peel of the citron contains a volatile oil of a yellow color, somewhat resembling that of the lemon. The skin of the citron being thicker than that of the lemon, it is employed in preference to the lemon for making the preserved peel. The principal countries which produce the citron are the tropical countries, India, Antilles and in some of the isles of Oceanica. In Europe in Provence, Spain, Italy, Malta, Africa, Algeria. Brandied citron is prepared in the same manner as brandied oranges, figs, etc.

Cherries.
Cérises.

Like the majority of the fruits already mentioned, the cherry is a native of Asia. It was imported into Italy by Lucullus. There are a number of varieties of cherries, which grow extensively in France, Hungary, etc. Cherries which are to be preserved in brandy must be large, fresh, and without spots or bruises. The stem is cut to half its length. The cherries are thrown in cold water to harden and to wash them. They are then strained and put in a cellar in a vessel containing alcohol prepared in the following manner:

Essence of coriander	250 c. c.
Essence of Chinese cinnamon	100 c. c.
Essence of cloves	50 c. c.
Alcohol (85°)	5 l. 800 c. c.
Water	3 l. 800 c. c.

Product, 10 l. of alcohol at 53°.

After six days of maceration put the cherries in a vessel and cover with a juice prepared as follows:

Brandy prepared from cherries	6 l.
Sugar	1 k. 250 grm.
Water	3 l. 100 c. c.

Product, 10 l.

For first quality juice take:

Cherry brandy	6 l. 500 c. c.
Sugar	2 k. 500 grm.
Water	1 l. 800 c. c.

Oranges.

The Seville orange or *chinois*, a bitter orange (*Citrus bigaradia*), is used principally for preserving green. The skin of the ripe orange is used in making curaçao.

The bitter orange is a native of all warm countries and can be grown also in a hothouse. It is this kind of orange which is generally used for ornament. The most highly esteemed fruit for this purpose comes from the island of Curaçao, which has given its name to the liquor made from them. A variety with a similar skin but much less highly perfumed is grown in Italy and the heart of France. The fruit used chiefly in France for preserving comes principally from Italy, Provence and Algeria.

Those which are chosen are of small size and when they are cleaned they are whitened in the following manner: The oranges are placed in a basin containing water, which is boiled to soften them. They are then thrown in fresh water and left to soak three or four days, renewing the water several times each day to draw off the bitterness of the fruit. The fruit is immersed seven times in a sirup marking 12° and augmented each time by four degrees.

The oranges are then thrown into a liquor prepared as follows:

Alcohol (85°)	3 l. 200 c. c.
Sugar	875 grm.
Water	5 l. 500 c. c.

For 10 l.

It is often advantageous to use preserved fruits. In this case treat the oranges as follows: Take the preserved fruit, put it on the fire with a small quantity of water. When the sugar is dissolved out, the fruit is allowed to cool in the same water and then it is placed in a vessel with the liquor named above.

Chestnuts.
Marrons.

The common chestnut (*Casteana vulgaris*, L.) grows in Europe, Asia Minor, America, as well as in Asia, where it originated. It is a large tree, furnishing a good quality of wood, and the nuts have a considerable commercial value. It grows by preference in a sandy soil, in granitic soil, in ferruginous, slaty soil or in silicious-argillaceous soil.

When it is desired to put chestnuts in brandy, preserved chestnuts must be used. Take chestnuts preserved in sugar and put them in a basin with enough water to wash them, warm the basin to assist the water in dissolving the sugary envelope, then allow the water to cool. The chestnuts are then placed in a liquid composed as follows:

Alcohol (85°)	3 l.
Sugar	1 k. 375 grm.

Raise the volume to 10 l. by adding water in which the chestnuts were soaked to remove the sugar.

Walnuts.
Noix.

The walnut is the fruit of the walnut tree (*Juglans regia*, L.), originally a tree of Persia. There are a number of varieties of the walnut which differ in size or form. Walnuts preserved in brandy are prepared in the same manner as chestnuts, the sugared fruit being washed to remove the sugar.

Peaches.
Pêches.

The peach (*Amygdalus persica*, L.) is, like the apricot, a native of Asia. It was brought from Europe in the time of the Emperor Claudius. Pliny was the first to give an exact description. He assures us that it came from Persia to Italy by way of Egypt and Rhodes. The peach is cultivated on trees and occasionally on trellises. The preparation of brandied peaches is as follows: Select fine peaches just before they reach maturity, prepare them in the same manner as for apricots, then cover them with white brandy at 58°. The juice can also be used to sweeten the peaches and other fruits having a pit.

Pears.
Poires.

The pear (*Pyrus*, L.) grows spontaneously in the forests of temperate Europe. The Romans carried it from Gaul to Italy. This tree is largely cultivated in France.

The pears are picked a little green, they are then stabbed to the center and whitened in water at 95°. When they begin to soften they are thrown in cold water. After cooling, the fruit is peeled and placed in cold water acidulated with lemon juice, then, after draining, is placed in brandy at 53°

Plums.
Prunes.

The plum (*Prunus domestica*) is a fruit tree which depends little upon the kind of soil in which it is grown. There are a number of varieties of the plum The different kinds have little interest for American manufacturers. The following is a description of the process of preserving one kind, and this will answer for all. Choose well formed plums, without blemish and very green, cut off the end of the stem, pierce to the center and place in cold water to harden. Then heat water to 95° in a bright red copper basin and add a little sea salt. Throw the plums in this water and leave the fruit until it rises to the top, and put them in cold water several times to refresh them, during an hour or two. The plums are then drained and recovered with white wine at 53° or 56°.

Grapes.
Raisins.

The variety chosen is generally the Muscatel. Grapes are preserved in the following manner: The grapes are chosen before they are perfectly ripe. The large grapes are taken one at a time and passed through water and pricked. The smaller grapes are crushed and the juice is mixed with three times its weight of brandy at 56°. This having been done, the smaller grapes are pressed and the juice is mixed with three and one-half times its weight of brandy at 56°, after 250 to 300 grm. of sugar per liter has been dissolved in it. This juice is filtered and serves to cover the choice grapes.

(To be continued.)

UTILIZING PETROLEUM WASTE.

IN the distillation of petroleum or hydrocarbon oils for the purpose of manufacturing illuminating gas, there remains a residue after the lighter portions are distilled away. This residue consists of water and heavy oil, which differs considerably from the tar which forms the residue of coal distillation. The characteristic of this petroleum residue is a tough, elastic, oily consistency, which causes it to envelop and cover small particles or globules of the water with which it is mixed with such persistency that it is impossible to separate the two by any ordinary known process. At the works of the Pacific Gas Improvement Company, at North Beach, N. Y., this residue has been allowed to run to waste, since it was not considered of any value for fuel or other purposes. J. P. Engle, of the firm of Engle & Son, dealers in lumber and mouldings, whose shop is near the gas works, now uses this material for fuel under the boiler in his shop, having devised and patented a means to effect a separation of the waste products and a way to recover them.

He employs an apparatus in which two surfaces are constantly rubbed together while the mixture is fed between them, so that the mechanical rubbing acts to

* Continued from page 14305, SUPPLEMENT, No. 895.

separate the heavy oil from the water and allow the latter to flow off separately from it. When this separation has once been made, the oil will remain separate from the water, and, being slightly heavier, will gradually sink to the bottom, so that the water may be drawn off from the top nearly or quite clear of the watery mixture. The oil thus separated may be used directly as a fuel or mixed with any dry refuse material which will absorb it and form a permanent fuel for future use, or it may be employed for any other purpose for which it is fit. In order to make a complete separation of the water from the oil, Mr. Engle employs any waste absorbent material, such as sawdust, shavings, cotton and woolen waste, rice husks, etc. A very simple apparatus is employed to complete the separation after the substances have passed through the mechanical rubbing apparatus. The peculiar property of the petroleum compound is such that the heavier portion is more readily absorbed by the dry material than the water. The consequence is that the oil and spirit will be absorbed first, and the water will remain unabsorbed and flow out immediately through a waste pipe, and the mixture thus formed is immediately ready for the grate. Mr. Engle says that it will then be found to produce a fuel equal in heat and endurance with the usual run of steam coal.

PROGRESS OF THE SORGHUM SUGAR INDUSTRY.

A LETTER to this station from one in charge of sorghum experiments under the U. S. Department of Agriculture in Kansas, says: "I believe now we can expect to have an average of 14 per cent. of sugar in the juice, and Dr. Wiley says we can now expect 200 pounds of sugar from a ton of such cane."

Dr. Wiley, in the *American Agriculturist*, says of the result in 1892: "Our own experimental results at Medicine Lodge were of the most satisfactory character. We produced some blocks of cane in which the average content of sugar in the juice was over 19 per cent. This of course is somewhat phenomenal and we could not hope to equal it in field work. I believe, however, that it is possible now to produce a field crop in that part of Kansas which shall contain an average of from 15 to 16 per cent. of sugar in the juice, with less than 1 per cent. of glucose, and with a purity of from 75 to 80. Such a crop could be most successfully and profitably manufactured."

During the season just passed results far more satisfactory have been secured than those which called forth the above predictions.

At Fort Scott, Kansas, the total sorghum cane worked for sugars was 4,276 tons, from which was obtained 490,900 pounds of sugar polarizing over 90 deg., and 60,450 gallons of molasses. The average polarization of the juice was over 13 deg.

At Medicine Lodge, Kansas, the total sorghum cane worked for sugar was 4,563 tons, from which was obtained 550,000 pounds of sugar and about 50,200 gallons molasses. The average polarization of the juice was 13·35 deg.

From the above we see that there was obtained at Fort Scott from each ton of cane an average of 114·8 pounds of sugar and 14 gallons of molasses, and at Medicine Lodge an average from each ton of cane of 120·5 pounds of sugar and 11 gallons of molasses.

That these results may be compared with those obtained from sugar cane I quote from *The Louisiana Planter*, which evidently regarded these yields as being at least as good, if not better, than average. It says: "The output at Point Houmas is estimated at about 740,000 pounds, making 126½ pounds to the ton;" and "on Mr. L. Forsyth's Pike's Peak plantation it is estimated that 2,500,000 pounds of sugar will be made, barring unforeseen mishaps—a yield of about 130 pounds to the ton."

It will be seen, therefore, that the results already secured, and upon a large scale, with sorghum, closely approximate those from Louisiana sugar cane.

But these results, though encouraging, do not limit the possibilities of sorghum, since one of the sorghum growers at Medicine Lodge reports his entire crop of one variety of sorghum as averaging 14 per cent. of sugar in the juice, the entire crop of three other varieties as averaging 15 per cent., the entire crop of two other varieties as averaging 16 per cent., and the entire crop of still another variety as averaging 18 per cent. of sugar in the juice, he had sixty-two acres in all, the entire crop from which averaged 15·84 per cent. of sugar in the juice, or 285 pounds of sugar to each ton of cane, and he reports an entire load of cane as yielding juice averaging 21·5 per cent. of sugar, while still another load averaged 22·3 per cent. of sugar, a result simply amazing when we consider that it shows the sorghum to contain fully one-fifth of its weight of sugar, or 400 pounds to the ton.

There still remains another matter of prime importance in connection with this subject, and that is the regularity of this crop as compared with those crops with which we are more familiar; and in this connection I quote from a correspondent who has had large experience, who writes as follows from Kansas:

"In the three years in which this work has been done here several of the varieties have varied less in the per cent. of sugar than sugar cane or the sugar beet, and in these three years the per cent. of sugar has averaged as high as in the sugar beet or in the sugar cane, while the per cent. of glucose has averaged less than in Louisiana sugar cane. So far, sorghum grown from true seed has been no more variable than sugar cane or sugar beet."

Another writes as to cost of manufacture as follows: "I find that I can cut, haul and mill our cane for less than $1 per ton. I believe this is the lowest cost that has been claimed for doing this work."

In reference to the constancy of the crop I would add that at the Experiment Station the past five years we have found several varieties of sorghum to have given in their juices an average in 1888 of 11·74 per cent. of sugar; in 1889 an average of 12 per cent.; in 1890, of 11·71 per cent.; in 1891, of 11·50 per cent.; and in 1892, of 11·65 per cent., or an average for five years of 11·72 per cent.—results as uniform during the five years as of any crop grown in the State.

The past season we have grown two varieties of sorghum upon the station farm at Geneva, the one yielding over 11 tons and the other over 20 tons to the acre. This crop was grown upon lands no better than tens of thousands of acres of the lands of central and western New York, and in practically the same way and by the same cultivation given to our corn crop.

It must not be forgotten that sorghum when fully matured yields a crop of seed equal in quantity to and practically identical in quality to the Indian corn and that this sorghum seed can be substituted for corn for every purpose for which the latter is used.

It would appear therefore that there was in the above facts much to encourage both the farmer in growing this crop and the capitalist who may think of entering upon its manufacture into sirup and sugar; and in the opinion of the writer the prediction of Margraff, who in 1747 urged upon the Berlin Academy the importance of his early experiments in extracting sugar from beets, declaring that in this root Europe would find the basis of an immense industry, a prediction now many years fulfilled, so now with far greater confidence, based upon vastly greater results already accomplished, one may predict at no distant future when the United States will find in sorghum the basis of one of its greatest and most profitable industries, and become in its cultivation and manufacture the leading producer, as it is now the leading sugar consumer of the world.

PETER COLLIER.

Geneva, N. Y., January 2, 1893.

TRICK WITH AN EGG AND A HANDKERCHIEF.

IN this trick we have an egg in an egg-cup, which the prestidigitator covers with a hat, and then he rolls a small silk handkerchief between his hands, as shown in Fig. 1. As soon as the handkerchief no longer appears externally, he opens his hands and shows the egg, which has invisibly left the place that it occupied under the hat, while the handkerchief has passed into the egg-cup (Fig. 3).

We shall now explain how these invisible transfers are effected.

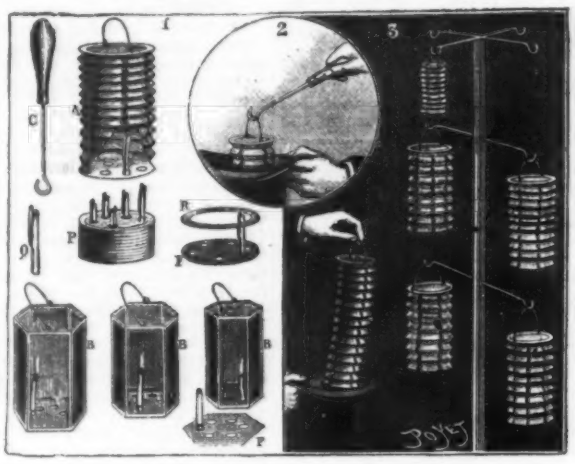
Two eggs, genuine and entire, were truly placed in plain view in a basket, but it was not one of those that served for the experiment. Behind the basket was placed a half shell, C, of wood (Fig. 2), painted white on the convex side, so as to represent the half of an egg, and, on the concave side, offering the same aspect as the interior of the egg-cup, A, to which it can be perfectly fitted in one direction or the other, as may be seen in the section in Fig. 2. It is this shell, inclosing a small handkerchief exactly like the first, that the prestidigitator placed upon the egg-cup (Fig. 2). Then, while with the left hand he covered the whole with a hat with which he concealed the operation, he with the right hand quickly turned the shell upside down. The shell, therefore, by this means, disappeared in the egg-cup, and the handkerchief, spreading out, assumed the appearance that it presents in Fig. 3.

The prestidigitator, having afterward secretly seized with his right hand a hollow egg of metal containing an oval aperture (F, Fig. 3), stuffed into it the handkerchief that he seemed simply to roll and compress between his hands. It is almost useless to add that the metallic egg may be easily concealed, either with the palm of the hand that holds it or with the handkerchief.—*La Nature.*

AN ILLUMINATION IN A HAT.

THE experiment of which our engraving gives an explanation consists in taking out of a hat half a dozen lighted Chinese lanterns, then a lantern a yard in length, and finally six glass lanterns with their candles lighted.

The lanterns, A (Fig. 1), consist of an upper circle, R, cut out of a thin sheet of metal, of the cylinder of figured paper familiar to every one, and of a bottom, F, of zinc provided with six small apertures arranged circularly at equal distances from each other. To one of the apertures is soldered a metallic tube of a slightly smaller diameter which is designed to receive a wax taper, Q, to which is affixed a wax match after it has been softened by the heat of the hands. The lanterns are placed one on top of the other in such a way that the tapers and the metallic tubes pass through the apertures of those that are above. The whole forms a package, P, that the prestidigitator secretly introduces into the hat, through one of those processes that we have already explained.



THE LANTERNS IN A HAT.

There are artists who, in order to avoid this slight difficulty, pursue with hat in hand, under some pretext or other, their assistant into the side scenes, where concealed from the indiscreet gaze of the spectators they fill the hat at their ease.

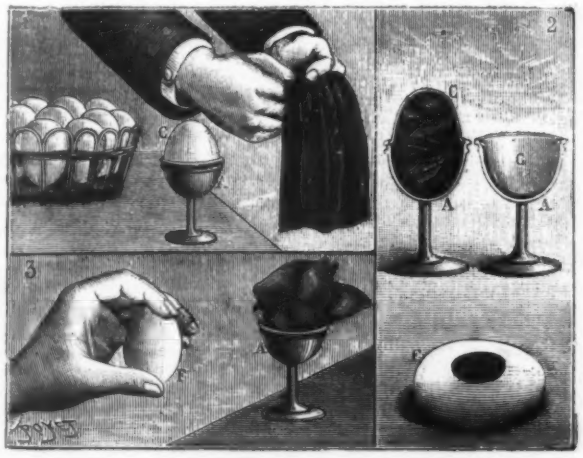
The prestidigitator, having first taken different objects from the hat, suddenly exclaims that he perceives fire in the latter. He wants to introduce his hand, but no, he is afraid that he may burn his fingers. He therefore asks for a hook, and, with the aid of this, he removes the lanterns one after the other (Fig. 2) and suspends them to a support arranged to receive them (Fig. 3).

The hook, it will be understood, has been placed in the fire and made very hot at its extremity, so that upon contact with it the matches of the two upper lanterns are ignited. Before taking out the second, its taper is inclined toward that of the third in order to light it, and so on to the end.

In the glass lanterns, B (Fig. 1), the arrangement of the bottom is the same as in the paper ones, but the lanterns enter one within the other. In order to prevent the spectators from remarking that the lanterns are not of the same dimensions, as would happen if they saw the first and last simultaneously, they are carried away in measure as they make their appearance.

They are introduced into the hat in the following manner: Placed one within another, and turned over obliquely upon a small bracket arranged behind the table, they are lifted by the middle finger, which is introduced into them, while the hat, held by the thumb and forefinger and resting upon the edge of the table, conceals the operation. It is exactly the process that we described in the experiment on the "birth of the flowers."

This experiment is very entertaining, and when well performed, never fails to produce quite an impression upon the spectators.—*La Nature.*



TRICK WITH AN EGG AND HANDKERCHIEF.

A PERPETUAL MENTAL CALENDAR.

By LYSANDER HILL.

PRELIMINARY REMARKS.

1. A century begins with the year ending with 01 and ends with the year ending with 00. For brevity, let us call the latter "century year," and, when it is leap year, "century leap year."

2. The old style calendar (O. S.) began with the Cæsars and ended on Friday, October 5, 1582, by the adoption of the new style calendar (N. S.)

Old Style.—Every year divisible by 4 without remainder was leap year. Each century, therefore, contained 25 leap years, or, in other words, 36,525 days=5,217 weeks and 6 days. Hence, each century began 1 day earlier than its predecessor.

New Style.—The leap years are the same as in old style, except that "century years" are leap years only when divisible by 400 without remainder. A century ending with "century leap year," therefore, has 25 leap years, or 36,525 days = 5,217 weeks and 6 days. All other centuries have 24 leap years, or, 36,524 days = 5,217 weeks and 5 days. Hence new style, every century immediately following a "century leap year," begins 1 day earlier than the preceding century, and every other century begins 2 days earlier than its predecessor.

3. A common year contains 365 days = 52 weeks and 1 day. Leap year contains 366 days = 52 weeks and 2 days. Hence the year immediately following leap year begins 2 days later than the preceding year, and every other year begins 1 day later than the preceding year.

4. The 1st, 8th, 15th, 22d, and 29th days of any month fall upon the same day of the week.

The above facts enable us to form four simple rules, by which the day of the week, of any date, can readily be found by a brief mental calculation. These rules enable us to find:

1. The day of the week on which the given *century* begins.
2. From this, the day on which the given *year* begins.
3. From this, the day on which the given *date* falls.

RULE 1.

To find the day on which any CENTURY *(new style) begins:*

Rule.—New style, all centuries begin on Monday, Saturday, Thursday, or Tuesday. The century immediately following any "century leap year" always begins *Monday;* the next century, Saturday; the next, Thursday; and the next, Tuesday. The days go backward as the centuries go forward. Thus, 1601 began on Monday, 1701 on Saturday, 1801 on Thursday; 1901 will begin on Tuesday, 2001 on Monday, 2101 on Saturday, and so on indefinitely. It is, therefore, very easy to find the first day of any century, new style.

RULE 2.

Having found the first day of any century, to find the first day of any given YEAR *therein:*

Rule.—The first day of any century recurs in regular cycles of 28 years during the century; and it also recurs in 6, 17, and 23 years from the beginning of each cycle. Thus the years 1801, 1829, 1857, and 1885 (cycles) all begin on Thursday, and any year occurring 6, 17, or 23 years after any one of these cycle years also begins on Thursday. This enables us readily to approximate any given year, and then run forward or back to it by the course suggested in remark 3.

Example.—What day of the week was January 1, 1893?

Ans.—By rule 1, January 1, 1801, was Thursday; by rule 2, January 1, 1885 (cycle year), and January 1, 1891 (6 years after cycle year), were also Thursday. From remark 3, we readily find that 1892 began on Friday, and 1893 (the year following leap year) began on *Sunday.*

RULE 3.

Knowing the first day of any year, to find the day of any DATE *during that year:*

Rule.—January and October begin on the same day of the week. May, 1 day later; August, 2 days later; February, March, and November, 3 days later; June, 4 days later; September and December, 5 days later; and April and July, 6 days later.

Memorize the following table:

0	1	2	3	4	5	6
Jan. Oct.	May	Aug.	Feb. March Nov.	June	Sept. Dec.	April. July.

NOTE.—In leap years all dates, after February 29, come 1 day later than indicated by this table.

Example.—July 4, 1893, comes on what day of the week?

Ans.—January 1, 1893, was Sunday; July 1 will come 6 days later, viz., Saturday. Hence, July 4, 1893, will be *Tuesday.*

Example.—July 4, 1892, was on what day of the week?

Ans.—January 1, 1892, was Friday; July 1, 1892, would, therefore, have been Thursday, but it being leap year, and later than February 29, it came on Friday; hence, July 4, 1892, was *Monday.*

General Example.—What day was September 24, 1843?

Ans.—By rule 1, January 1, 1801, was Thursday; by rule 2, January 1, 1846 (17 years in cycle 1829–1857), was also Thursday. Hence, by remark 3, we find that January 1, 1845, was Wednesday; January 1, 1844 (leap year), was Monday; and January 1, 1843, *Sunday.*

Then, by rule 3, September 1, 1843, was Friday; hence, September 22 was Friday, and September 24, 1843, was *Sunday.*

In the old style calendar, when we have found the first day of the century, we find the first day of the given year, and the day of the given date therein, by rules 2 and 3, the same as in new style.

But those centuries being all of equal length, and each beginning 1 day earlier than its predecessor, we must memorize the day on which some one of them began, and then reckon from that—an easy operation—because the same day will recur every seventh century.

The last century, old style, began on *Friday,* January 1, 1501. Taking this (memorized) as the starting point, we readily find that—

January 1, 1401, was Saturday;
January 1, 1301, was Sunday;
January 1, 801, was Friday;
January 1, 101, was Friday;
January 1, 601 B.C., was Friday;
January 1, 1301 B.C., was Friday, etc.

Example.—October 12, 1492, was on what day of the week?

Ans.—January 1, 1401, was Saturday; hence (by rule 2) January 1, 1485 (cycle year), and January 1, 1491 (6 years after cycle year), were Saturday; and January 1, 1492, was Sunday. January 1 being Sunday, October 1 would have been Sunday had it not been leap year—but was one day later, viz., Monday. October 8 was, therefore, Monday, and October 12, 1492, was *Friday.*

Rule 3 will be found very convenient in daily practice, as it enables any one, by simply remembering on what day the current year began, to pass readily to any date during the year without the necessity of resorting to a printed calendar.

A SCHOOL IN PERSIA.

WHILE other countries are considering co-education and university education for women, Persia still excludes them from even the common schools, one of which is shown in the accompanying engraving (for which we are indebted to *L'Illustration*). These are literally "public schools," being always on the public road and not inclosed at all, and each one is provided with two instructors, a chief and an assistant. The classes are more or less numerous, and the pupils generally study aloud, either in groups or separately.

Besides these ordinary places of instruction there are some which might be termed colleges, and the polytechnic school, in which a number of professors of different nationalities teach mathematics, geology, music, military tactics, physics, chemistry, etc.

A SCHOOL IN PERSIA.

THE AMERICAN PSYCHOLOGICAL ASSOCIATION.

ONE of the most significant meetings that occurred during the Christmas holidays was that of the American Psychological Association, in Philadelphia, on December 27 and 28. This was the first regular meeting of this body, a temporary organization having been effected in June last. The coming together of psychologists is significant not alone of the rapid strides which this science has recently been making, but particularly of the unity of method and subject matter which the introduction of scientific modes of observation into this controverted field has made possible. This association of psychologists is composed almost exclusively of specialists who are studying the nature of mental processes by the help of ingeniously devised apparatus, are propounding new problems and adopting new methods to their solution, and, in brief, are proceeding with that painstaking vigor and caution characteristic of all phases of modern science. For these reasons an account of their proceedings necessarily becomes somewhat technical; but this moderate element of techicality is itself a welcome relief from that overpopularization and almost sensational publicity in which a line of activity too often confused with psychology has indulged.

The meeting was called to order by the president of the association, President G. Stanley Hall, of Clark University, and the reading of papers began with a paper by Professor Catell, of Columbia College, on "Errors of Observation in Physics and in Psychology." Professor Catell criticised that line of psychophysical observation in which the liability to degree of error was taken as a standard of the sensibility for differences. He considered that the entire subject needed reinvestigation, with a complete separation of these two points. He also regarded that recent experiments of his own and Professor Fullerton tended to show that the errors of observation do not fall under the law as usually stated (Weber's law), but approximate the law which the distribution of errors demanded.

A very interesting problem was presented by Dr. Witmer, of the University of Pennsylvania, in an account of a research upon the æsthetics of visual form. Dr. Witmer attempted to determine, by a large number of experiments, such questions as: What are the most pleasing forms? What proportions of the division of a line, and what proportions of the relations of the height to the breadth of a rectangle, are the most pleasing? and the like. The results of these preferences were interpreted by reference to the general outline of the field of vision, of which the figures form a part. He showed conclusively that the former views of the conditions of such æsthetic judgments were inadequate, and that this neglected factor of the position of the figure with reference to the edges of the field of vision was a most important one. The experiments will be continued, and give promise of contributing some measure of system and order to a field usually regarded as determined by caprice.

President Hall presented a brief outline of the history and prospects of experimental psychology in America, tracing the beginnings of this study from the first laboratory founded at Johns Hopkins University some eight years ago, up to the present time, when there are as many or more psychological laboratories established in this country than in all Europe. The rapid dissemination of interest in psychological studies and the material provisions for its future development were ably presented, and various measures of credit judiciously assigned. The publication of such a review of the purposes, methods and results of the new psychology, as President Hall outlined, should certainly contribute much toward a more general understanding of what psychology and psychologists are doing, and, equally important, not doing.

Professor Jastrow, of the University of Wisconsin, gave an account of the exhibit of experimental psychology which is to be made at the World's Fair. Here, for the first time, the attempt will be made to gather together various types of apparatus which are used in psychological research, to maintain in running order a working laboratory, in which simple tests of the senses, powers of judgment, the times of mental processes, the peculiarities of association, the limits of memory, of fatigue and the like, may be made and recorded; and to exhibit in some measure the results of statistical and other forms of research. Considerable expenditure, the co-operation of colleges, of individual psychologists and of makers of apparatus have been secured for the successful completion of this large task. It is hoped that this somewhat comprehensive exhibit of the method and aims of this new science may aid in disseminating a truer and more appreciative view of the theoretical and practical value of this line of research than has yet been accomplished.

Professor Munsterberg, of Harvard University, upon the request of the president, addressed the association, speaking of the problems that were engaging his attention at his laboratory at Cambridge. No less than fifteen subjects of investigation are here in progress, and the nature of some of these Professor Munsterberg described in a very interesting manner. The impetus to work in this direction, which his acceptance of the chair at Harvard has given, has already made itself evident, and, before the year is over, many important results will undoubtedly be issued from his laboratory. The subjects under investigation covered a wide range, from the determination of the methods of localizing sounds in space, and a new method of determining when differences of sensation may be regarded as equal to complicated experiments upon the nature of association, of changes in mental condition, of complex forms of reaction and the like.

Dr. Sanford reported some of the minor studies which are in part completed and in part in progress at the laboratory of Clark University. One of these studies gave an account of the fluctuations in mental power at different portions of the day, as determined by the capacity to remember a series of arbitrary impressions. Another dealt with the frequency and character of dreams of subjects who every night at once recorded their dreams upon awakening from them. The great frequency of dreams, the fact that they are concentrated in the early hours of the morning, that they are so largely based upon actual experiences, and that recent events contribute much to their content; these and other points clearly appeared in the analysis which this material furnished.

Professor Bryan, of the University of Indiana, presented two papers, in one of which he gave an account of experiments establishing the effect of the intensity of the stimulus upon the reaction time, and in the other described some tests which had been made in schools of Springfield, Mass. These tests show the development of motor power in children at different ages, and brought out many unexpected and significant relations.

Papers were also read by Dr. Nichols, of Harvard College, presenting some novel experiments upon illusions of rotation and upon the sense of pain; by Professor Pace, of the Catholic University of Washington, describing some observations upon the power of judging the thickness of surfaces held between the thumb and forefinger; by Dr. Witmer, describing the results of a few simple reaction times, taken upon a great va-

riety of unpracticed subjects. Other papers of a somewhat philosophical nature were presented by Dr. Chamberlain on the "Relation of Psychology to Anthropology," and Dr. Aikens on an "Analysis of Cause."

The meeting adjourned, to meet next December, at Columbia, N.Y. The officers of the association are: G. Stanley Hall, president; Professor Ladd, of Yale University, vice-president; and Professor Jastrow, of the University of Wisconsin, secretary.—*Science.*

REMINISCENCES OF PENIKESE.

Mrs. HELEN B. C. BEEDY, Bangor, Me.

THE twenty years since the first seaside school in America was established at Penikese Island have been years of such marked progress and evolution of new methods of teaching in natural history that there has hardly seemed time even to stop to be grateful to the originator of these methods, our beloved and honored Agassiz.

He it was who gave the impetus to the study of natural history in America—not from books but from nature herself.

Among the memories of Penikese that come thronging back are not so much "The Formation of Glaciers," the "Ice Sheets that Covered this Continent" or "Classification in Natural History," as the man, Agassiz, whose genial countenance always bore the index of his great heart.

Standing before his class, crayon in hand, he seemed not to see the eager students before him, but rather the children all over the land for whose faithful instruction he pleaded.

Every lecture became a lesson in method. No matter how intricate the scientific subject he was presenting, he often broke the thread of his discourse, to impress some lesson in method or to call attention to some truth bearing upon the ethics of everyday life.

Turning to my note book, I read between the lines: "Consult no one in regard to your modes of life. The time will come when that which *is* in nature will be expressed—not what any naturalist may divine. The conceit of originators must be overcome. Aim to be translators, not originators. Always mark specimens carefully. Attach label so as not to be removed. There should be a little museum in every school room. I would prefer that you go home with a dozen specimens well studied and identified than to learn much. Self-conceit retards progress. The study of nature is humiliating. Nature is always right. If there are errors, it is we who are in the wrong. We must be willing to know little, but know that little well. Every student must have his own opinions. All studies that go deep benefit one. Never attempt to teach what you do not know yourself well. Teach pupils to be observers. The study of nature, if done in the right spirit, is an intercourse with the highest mind. A laboratory is to me a sanctuary, and I would have nothing done within it unworthy of its great Author."

Those who enjoyed that golden summer with Agassiz at Penikese can never forget his earnest appeals to them as teachers to help him make the true way of teaching universal throughout the country by leading their pupils to study natural objects. How faithfully they have heeded his instruction the great demand for summer schools, seaside laboratories, field classes in botany and geology abundantly testifies. The teacher who to-day would attempt to instruct a class in botany or zoology without specimen in hand would not be tolerated even in our rural schools.

Work and recreation were combined in the Anderson school. The social hours were very delightful. After the busy day in the laboratory it was our custom to assemble on the little hill, the only eminence upon the island, and there near the flagstaff which had been planted amid some small bowlders, seat ourselves upon the dry grass to hear the conversation of Agassiz and his associates, or join in singing while we watched the bright tints of Gay Head as it gave back the last rays of the setting sun, or marked the position of the lightships as they sent their glimmer across the waves.

It was very touching to note the unaffected friendship of Agassiz and Guyot, who had been lifelong friends. It was not unusual to see them walking together over the island of Penikese, with their arms fondly folded over each other rehearsing their boyhood days, or living over again their perilous excursions among their native Alps. The natural history club founded by the teachers and students for the discussion of methods of teaching was an attractive feature of the school.

When Mr. James Johonnot asked, "When shall we commence to teach natural history?" Professor Agassiz struck the keynote of all his teachings when he replied, "At once, using the material nearest at hand." Sometimes small parties of us gathered in the shadow of the great rock for more quiet reading or sketching. As there was not a tree upon the island, this huge bowlder, beneath the scorching July sun, was a striking illustration of what Isaiah must have had in mind when he compared the prophetic kingdom to the shadow of a great rock in a weary land.

Professor Agassiz always quoted his friends in such a way that their names seemed to linger in love upon his lips. This was specially true of Cuvier, with whom he had enjoyed the closest friendship. To Agassiz, Cuvier himself had intrusted his drawings and notes on fossil fishes, and placed at his disposition all the material he had collected for the great work to which he had devoted his life.

The last words of Cuvier to Agassiz were: "You are young, you have time enough for the work. I have none to spare. Be careful and remember that work kills."

At the death of Cuvier, Agassiz was the only man in Europe deemed competent to take up his unfinished work. Humboldt, too, was Agassiz's personal friend, and in the home-like lectures and talks at Penikese the students got glimpses of these great men that could not be obtained in any other way. He often spoke of Humboldt as his benefactor. It was through his kindness and liberality that Agassiz was able to publish his great work on fossil fishes. For Darwin, Agassiz had only words of kindness; he spoke of him as "my friend—I like him much."

We were greatly amused after a lecture at Penikese in which Professor Agassiz had spoken of Darwin, when one of the teachers narrated the conversation in which Darwin's son, when told that Agassiz did not accept his father's views of evolution, replied, "Very well; my father does not believe in the glacial theory."

This man Agassiz, so great—a member of all the scientific academies of Europe and of the learned societies of America—equally at home with the savants of the old and new worlds; with the living and the dead; as familiar with the works of Aristotle as Cuvier; an honored guest at the homes of the monarchs of Europe and the less pretentious firesides of America; this man mingled freely with his students at Penikese and entered into their personal interests with an enthusiasm born only of greatness. His artless simplicity of character was constantly revealing itself in his kindly attention to the students. How vividly I remember a Sunday morning call from him and Mrs. Agassiz, in the dormitory. Our rooms, so neat and comfortable, boasted of but two chairs. He refused the one offered him and seated himself upon a trunk too wide and high to admit of his feet touching the floor. I had taken great pains to send home for my autograph album, but hardly as brave as Wagner in Faust, had hesitated to ask him for his name—but this seemed my opportunity; producing the book, I said: "Do you object to writing your autograph, Professor Agassiz?" All those who have ever heard the musical tones of his voice, will recall them in the familiar answer, "Certainly not." And now as I read, "Lz' Agassiz," and below on the same page, "With pleasant memories of the first summer at Penikese, yours truly, Elizabelle C. Agassiz," there comes to me not only the memory of the man but also that of the noble woman who so faithfully co-operated with him in all his labors for the enlightenment and uplifting of humanity.

One of the pupils had been invited by her State superintendent of schools to prepare a paper upon the work at Penikese, to be read before the State teachers' association. She took the matter to Professor Agassiz and asked him if he thought she could fittingly present the subject before such a body. He replied, "Certainly. You can do it better than I; you are nearer them."

The storm of Aug. 18, that detained Prof. Benjamin Pierce and his yachting party upon the island, blew no ill wind to the students. Professors Pierce and Agassiz were genial friends. He was easily induced to address the school and was listened to with marked attention. His first words were: "The great need of the world to-day is men of truth." As Professor Agassiz was afterward taking him through the laboratories, pointing out the work of the students, they came upon a party of us gathered around the table of Miss Lydia W. Shattuck (always the center of a loving group), busy over the algæ we were preparing for preservation (for which we were not unwilling to leave the dissection of fish and lobsters), he remarked to Professor Pierce, "You see ladies will do ladies' work."

Professor Agassiz constantly urged: "You can do if you think you can do." But every student of his knows that the thinking to do can come only after careful study and research. His own zeal knew no bounds. From boyhood he had grappled with every obstacle the lover of truth is called upon to surmount. Without this life-long experience the Penikese school would have been greatly delayed in its opening. The school was not decided upon until March, but dormitories and laboratories were begun in May and the school was to open July 8. In the meantime apparatus for working was to be provided and provision for the comfort of fifty pupils and a large corps of teachers was to be made.

When Professor Agassiz arrived upon the island, July 5, things were in a very unfinished condition, but with his characteristic zeal everything was made ready, and when the steamer brought the school at the appointed time, they found the bare, unfinished walls of a few days before transformed into airy and comfortable sleeping halls; the barn metamorphosed into dining room and lecture hall, while in and out of the great barn doors the swallows were still permitted to pass to their nests in the rafters.—*Education.*

CARL WILHELM SCHEELE, PHARMACIST AND CHEMIST.

A BRIEF ACCOUNT OF HIS LIFE AND WORK.

THE subject of this note was born on December 9,* 1742, at Stralsund, which was at that time the chief town in that part of Pomerania which was united with Sweden after the peace of Westphalia, though from its position it naturally formed part of Prussia, to which it now belongs. Scheele was thus a Swedish subject, but he may be regarded as strictly of German nationality. German was his mother tongue, and, though practically the whole of his life was passed in Sweden, he never attained any degree of intimacy with the language of the country. The accounts of his researches were invariably written in German, and had to be specially translated into Swedish in order that they might be inserted in the transactions of the learned societies to which they were communicated. His father, Joachim Christian Scheele, a respectable tradesman and burgess of Stralsund, belonged to an offshoot of a widespread and wealthy family of some note, members of which had filled prominent positions. Margaretha Eleonora Warnekross, the wife of Joachim, was the daughter of the head of a firm of brewers in the same town. They had, in all, eleven children, of whom Carl was the seventh.

EDUCATION AND APPRENTICESHIP.

The means of his parents do not appear to have sufficed to enable them to give their sons an extended academical education, for we find that after Carl had studied during three years at a private school where he was compelled to make some progress in Latin, though he never showed either inclination or aptitude for the study of languages, he was transferred to the gymnasium or public school at Stralsund. This, however, he soon left, to enter upon the serious business of life. An elder brother, Johann Martin, had been apprenticed with Martin Anders Bauch, an *apotekare* or pharmacist of Gothenburg and a friend of Scheele's family, but had died during his term of pupilage. It was found that Carl's inclination prompted him to enter the same profession, and in 1757, when he was fourteen years old, he also was put under the charge of Bauch. During the eight years he stayed here he displayed no exceptional ability, though he is described as being thoughtful and studious, as well as very punctual and precise in the discharge of his duties.

* L. Von Crell (*Chemical Journal*, i., 1) incorrectly gives the date as December 19, and the error has been copied in other biographies, including that in the *Encyclopedia Britannica*.

STUDIES AND EXPERIMENTAL WORK.

He studied carefully such standard works on chemistry as then existed, the chief being Caspar Neumann's *Prælectiones chemicæ*, Lemery's *Cours de chimie*, Boerhaave's *Elementa chemiæ*, Von Lowenstern's *Laboratorium chymicum*, Rothes' *Anleitung zur Chymie*, and Kunckel's *Laboratorium chymicum*, the last named especially interesting him and occupying much of his leisure time. During business hours he planned experiments to be performed in his leisure time, his practical work often extending far into the night, and, by repeating the experiments described in his books and systematically subjecting the substances around him to careful examination, he gradually acquired a considerable stock of knowledge as well as unusual skill and dexterity in manipulation. In 1765, Bauch sold his business and Scheele left for Malmo, in Sweden, to engage himself with Peter Magnus Kjellstrom, also a pharmacist. While here he continued to devote himself to his favorite science, and it is related that he once got into trouble over it. He was conducting some experiments with the pyrophorus when, a fellow apprentice having unknown to him mixed some fulminating powder with the material he was working with, an explosion occurred, and the violent detonation in the middle of the night alarmed the household. The reprimand he received did not diminish his ardor, however, but simply had the effect of causing him henceforth to conduct his experiments more cautiously.

FIRST CHEMICAL DISCOVERY.

Scheele's next engagement was with Scharenberg, of Stockholm, who kept a pharmacy at the sign of the Raven. Arriving here in 1768, he stayed but a brief time, during which, however, he completed his first research of importance, isolating tartaric acid from cream of tartar and ascertaining many of its properties, as well as those of several of its compounds which

CARL WILHELM SCHEELE, PHARMACIST AND CHEMIST.

he prepared. A record of this work was sent to Torbern Olof Bergman, then professor of chemistry and mineralogy at the University of Upsala, who by some mischance neglected it and returned the manuscript unread. Subsequently it fell into the hands of Anders Jahan Retzius, professor at Lund, who recognized the importance of Scheele's results, and secured the insertion of his paper in the Transactions of the Academy of Sciences, Stockholm, for 1770, without, however, naming Scheele as the author.

FRIENDSHIP WITH BERGMAN.

In the autumn of the same year, Scheele obtained a post as chemist in the laboratory attached to the pharmacy belonging to Lokk, of Upsala. This change was made that he might take advantage of Bergman's lectures, but his excessive modesty and timidity, coupled with the soreness he yet felt with regard to the tartaric acid incident, prevented him taking steps that would bring him in contact with the famous chemist. Accident, however, brought about their acquaintance. Jean Gottlieb Gahn, the assessor of mines at Fahlun, was at this time studying chemistry at Upsala, and being one day at the pharmacy whence Bergman's laboratory was furnished, engaged in conversation with Lokk concerning a peculiar reaction the latter had noticed on adding vinegar to niter after it had been heated over a quick fire. Gahn was unable to explain this, but undertook to ask Bergman, who proved to be equally ignorant upon the point. Calling to inform Lokk of his failure to obtain the desired information, Gahn found him absent, and addressed himself therefore to Scheele, who to his surprise explained the matter without any hesitation or difficulty, stating that an acid (nitrous) was given off which differed from the acid of niter (nitric) generally known, and showing how this was brought about. As a result of this episode, the two students soon became intimate, and communicated the details of their respective researches to each other, while later, Gahn persuaded Scheele, not without difficulty, to meet Bergman, who at once acquired a strong liking for the young pharmacist. They soon became great friends, and their friendship never weakened, lasting till Bergman's death in 1784. The professor adopted many of Scheele's views, assisted him to publish all his discov-

eries, and secured his election as an associate of the Academy of Sciences. It is related by Dr. Beddoes that a relative of Bergman observed to him that "the greatest of Bergman's discoveries was the discovery of Scheele."

FURTHER RESEARCHES AND DISCOVERIES.

About this time Scheele published the results of his researches on the composition of fluorspar, from which he obtained what he termed "fluor acid." This was actually, for the most part, fluosilicic acid; for the experiments had been conducted in glass vessels, and the hydrofluoric acid given off naturally entered into a fresh combination. In 1774, the results of his investigation of black oxide of manganese were published. While working with this substance he obtained oxygen, chlorine, and nitrogen, in the free state, discovered baryta, which occurred as an impurity in the manganese, prepared the green and red manganates of potash and other salts, and discovered how manganese affects the color of glass. The following year he precipitated benzoic acid from its lime solution, and proved it to be identical with that produced by sublimation. He also investigated arsenic acid, studied its reactions, and prepared several of its salts; discovered arseniureted hydrogen and the pigment since known as Scheele's green, and later published a process for the preparation of the latter on a large scale.

ESTABLISHMENT IN BUSINESS.

About 1775 he began to feel that more calm and quiet surroundings were essential for his work. Bergman did his utmost to detain him at Upsala, and many inducements were held out to him. In the name of the government he was offered a professorship and the control of several factories, but all without avail. By the death of Hinrich Pascher Phols, the proprietorship of a pharmacy at Koping, a small town to the northwest of Lake Malar, fell vacant. On Scheele's application, he was nominated *provisor* of the establishment, and entered upon his duties in the summer of this year. The business proved to be in a very poor condition and hampered by Pohl's debts. By setting to work assiduously, however, and introducing an orderly system into the establishment, Scheele secured a fair share of support, and in two years' time was enabled to make arrangements to purchase the business, after paying off all debts. At this period he was required to submit himself for examination before the Royal College of Medicine,* and on November 11, 1777, he was admitted to be registered as a pharmacist. It is stated that the college authorities, doubtless influenced by his lofty reputation, dispensed with the usual formalities in his case, and omitted the fees usually demanded on taking degrees. This would be a matter of some consideration to him, for, making it a point of honor to do his best to provide a competency for his predecessor's widow, Sara Margaretha Sonneman, for whom he soon conceived an attachment, though he would not make her his wife until he was in a better position to do so, Scheele labored under great pecuniary difficulties, from which he was never quite free for the rest of his life. He was relieved to some extent by the receipt of a grant from the Academy of Sciences, obtained for him by Bergman's influence, but he would not use more than one-sixth part of this for his personal needs, the remainder being kept to meet the expenses of his experimental work.

LATER THEORIES AND DISCOVERIES.

During the remaining nine years of his life most of his discoveries were made. Thanks to Bergman everything he published received immediate attention; and information concerning his additions to the stock of chemical knowledge was speedily diffused among scientific workers. Every year two or three of his papers saw the light, each one of these recording some fresh discovery, describing new compounds, or embodying explanations of misunderstood chemical phenomena. Thus he investigated the nature of quartz, silica, clay, and alum; discovered uric, oxalic, lactic, mucic, tungstic, critic, molybdic, gallic, and malic acids; suggested new methods of making calomel, powder of algaroth, ether and magnesia; and showed that plumbago is simply carbon with a small admixture of iron. The results of his experiments upon the proportion of pure air (oxygen) in the atmosphere accorded with those of Lavoisier; he discovered glycerin while working with animal fats and fixed oils; while in the research which is regarded as his masterpiece, and exhibits his experimental genius at its best, he determined the nature of Prussian blue, and isolated prussic acid, of which he described the composition, compounds, and properties, though he appears to have been totally unaware of its deadly character. In his treatise on "Air and Fire" he demonstrated that the air consists essentially of two gases, one of which supports combustion, while the other does not. The former he identified with the "fire air" he obtained from saltpeter, nitric acid, black oxide of manganese, and other substances. He endeavored to associate several phenomena with the action of this gas, particularly connecting it with the respiratory function and the growth of plants. Incidentally he prepared and described sulphureted hydrogen, and by his experiments on the action of light upon chloride of silver and other substances, he took the first step in the direction of discovering the art of photography.

RESOURCES AND CAPABILITIES.

He was not content merely to prepare the numerous substances he discovered, but also made every compound of these that was possible at the time, and gave detailed descriptions of the methods adopted for their production. His labors and results were the more remarkable in that he had received no training in chemistry, and in the then undeveloped state of the science could obtain but little aid from books. His ignorance, too, of other languages than German prevented him utilizing much contemporary literature. He was thus compelled to work out afresh many already published details, and was practically obliged to do everything from the beginning, his entire work being thus of necessity original in the fullest sense of the word. The lack of suitable apparatus, even in the great laboratories connected with the universities, was then very great, while Scheele, far from every center of instruction and without the scanty resources of science that did exist, had practically nothing in the shape of accessories except such as he could contrive for himself. However, in the midst of the detail work of his daily round, he devised ingenious apparatus destined to elucidate the most abstruse and difficult problems in chemistry. In many respects he resembled our own Faraday, and particularly in the simplicity of the means he employed as contrasted with the importance of the results he obtained. It is stated that a furnace, alembic, sandbath, crucible, some phials, ordinary tumbler glasses, and a few bladders to contain gases, constituted his laboratory. With these he was able to discover and investigate gases, metals, acids, and many other substances. Working at a time when a veritable revolution was taking place in chemistry, when the labors of Black, Cavendish, Priestley, Bergman, Berthollet, Lavoisier, and others were all tending toward setting it upon a more exact basis, Scheele brought to the new scientific edifice a tribute of numerous experiments and facts deduced therefrom. He thus added considerably to the riches of the science and aided in the establishment of important new doctrines. In this power of experimental research he probably has had no equal

APPARATUS USED BY SCHEELE IN HIS EXPERIMENTS ON AIR AND FIRE.

but Faraday. Naturally endowed with the true scientific instinct, he also possessed unwearied patience and gave an undivided attention to his work, for the study of science was to him both work and relaxation.

DIFFICULTIES, ILLNESS, AND DEATH.

At the same time he omitted no share of his ordinary professional duties, and, seeing that he was also continually worried by the difficulty of fulfilling the obligations he had entered into with regard to the purchase of the business, it is little wonder that he was prematurely assailed by infirmities, prominent among which was rheumatism, induced by the draughts to which he exposed himself in his devotion to night work. His strength being exhausted by long years of privation and self-neglect, he succumbed within two months, when his disorders culminated in what proved to be the fatal attack. On his death bed he fulfilled the resolution he had previously formed, marrying the widow of his predecessor, that he might leave her his name (thus entitling her to benefit by the after disposal of his pharmacy) and the small savings he had accumulated. He died two days afterward, on May 21, 1786, at the early age of forty-three years.

METHOD AND ACCURACY OF WORK.

Scheele's discoveries are described as being invariably the outcome of carefully planned experiments, intended to test theories he had previously formulated. By thus excluding all haphazard experiments, he economized time, material, and labor, attaining conclusions more speedily and without unnecessary complexity of the means to be employed. In the description of his traits penned by one biographer the resemblance to Faraday is most striking; for we are told he left nothing in doubt if experiments could be devised to establish the point, he grudged no labor to make the truth indisputable, and never considered his work complete with respect to any compound unless he could both make and unmake it. His one aim in life was the experimental discovery of truth in nature, and his accuracy is described as unrivaled, considering his position and the means at his command, while the work he executed left hardly anything to be added to it, being "as thoroughly well done as it is in the power of an all-conscientious man to do." Dumas, whose opinion is of considerable value, asserts that "whenever it is a question of facts, Scheele is infallible. He rose to the highest rank he could attain by work, experience, and thought, without the aid of any scientific education. Whether he could have risen higher, I know not; still, when it is commonly said that in order to work for the advance of science, it is necessary to live in the great university centers, and not in the atmosphere of provincial life, we cannot help turning our thoughts on Scheele and Koping."

ENGLISH RECORDS OF EXPERIMENTS.

An English translation of Scheele's treatise on "Air and Fire," by J. R. Forster, was published in 1780, and of his "Chemical Essays," by Thomas Beddoes, in 1786. These are well worthy of perusal, and may be commended to the attention of all pharmacists, particularly younger ones who are eager to undertake original work in chemistry. After receiving a proper training as students, they can have no fitter exercise, before proceeding further, than to carefully follow step by step in the path first trod by one of the greatest masters in the science. The details of Scheele's experiments are so succinctly explained in his works, and the means he employed were so simple, that no one should find difficulty in repeating the researches which lead to his most noted discoveries. Then, having acquired a knowledge of the famous Swede's painstaking and well thought out methods, independent researches may be undertaken with less risk of haphazard experiments and clumsy guess work, and greater possibility of a successful issue. It should be noted, too, how important was the influence upon Scheele's investigations of his training as a pharmacist, for the fact cannot be overlooked that pharmacy was to him the stepping stone by which he rose to higher things. Had he not been a pharmacist, in all probability chemistry would not have claimed him for her own. His first essays in analysis, which resulted in his earlier discoveries, dealt almost exclusively with the substances of special pharmaceutical interest, and, during these labors, he doubtless imbibed the principles and gradually formulated the theories which led to the greater researches that have immortalized his name.

DISTINCTIONS AND MODESTY.

To those connected with pharmacy who are apt to disparage their craft, it may be pointed out that Scheele was from first to last a pharmacist, despising all preferment and remaining unaffected by any distinctions conferred upon him. Visitors used to find him wearing the traditional white apron, and performing the regular routine work of the pharmacy. Without apology, he would continue the work he had in hand, while discussing with them the progress of science and the researches of himself and his friend Bergman, whom he described as "the honor of Sweden," never apparently realizing that his own claim to that title was incomparably greater. We are told that he refused the invitation of the King of Prussia to settle at Berlin, as well as the offer of an easy and lucrative position made by the then government of England. The academies of Berlin, Erfurt, and Turin, and the Royal Society of Medicine at Paris, were eager to admit him to share the privileges they enjoyed, but preferring the comparative freedom of an humble pharmacy in an out-of-the-world corner, he "made chemistry transcendent in his back shop with medicine phials and retorts, as Pascal discovered the theorems of geometry without other instruments than compass and rule."

POSTHUMOUS HONORS IN SWEDEN.

A statue, by Borgeson, to Scheele's memory, representing him as engaged in experimental work, and with the instruments of his craft around him, was erected by the Swedish people, and formally unveiled on December 9, 1892, that being the one hundred and fiftieth anniversary of his birth. The Swedish Pharmaceutical Society, recognizing as the president of the British Society has recently expressed it, that "Scheele represented the highest type of pharmacy and, with a certain number of other men of like character on the Continent, made pharmacy and chemistry respected all over Europe," has had a medal struck as a reminiscence of the occasion, and this, by a happy thought, is composed of aluminum, a metal the native compounds of which Scheele was one of the first to investigate. The statue is represented on one side of this with the date MDCCCXCII., while a sketch of his pharmacy at Koping and the dates MDCCLXXV.–MDCCLXXXVI. occupy the other. The former is encircled by the words "Carolo Gvil. Scheele Pharm. Chem. Grati Cvltores Ordo Pharm. Svec.," and on the reverse occurs the following exceedingly appropriate inscription: "Domestici Parietes Ipsum Non Famam Continvervnt."

On the one hundredth anniversary of Scheele's death, in 1886, a memorial notice, written by Dr. P. T. Cleve, Professor at Upsala University, was published at Koping, describing the life and work of the famous chemist. This is illustrated with a fine portrait, sketches of the pharmacy at Koping and apparatus used in the laboratory there, together with representations of the memorial tablet in the church at Koping, a facsimile letter by Scheele, and the projected statue by Berjeson, the latter apparently copied from a preliminary sketch and differing in some respects from illustrations representing the finished sculpture. An exhaustive memoir, on a much larger scale, edited by Baron Adolf. E. Nordenskiold, Professor at the Royal Academy of Sciences, Stockholm, was published in Stockholm late in 1892. This includes a very complete biographical sketch, all Scheele's letters to Bergman, Gahn, Lavoisier, and other correspondents, and a reprint of his laboratory note book. It is illustrated with a photo engraving of the recently unveiled statue, a sketch of the pharmacy and drawings of some of the apparatus at Koping, together with facsimiles of a letter and some pages of the laboratory book in Scheele's handwriting.

In various ways then the Swedes, and particularly the pharmaceutical section of the community, have endeavored to perpetuate with distinction the memory of one whose labors, with their brilliant outcome, reflect honor upon every member of the craft with which he was all his life associated. But his reputation is not merely a national affair. His passion for science, of which nothing but a study of his works can give an adequate notion, was intense, and he was so single minded in his devotion to that branch which specially attracted him that his fame as a chemist became universal. His worth was fortunately recognized to a considerable extent during his lifetime; and the great services he rendered in the gradual but progressive revelation of truth justly entitle his memory to all esteem and honor in every part of the civilized world. For us his name is indissolubly associated with a compound—prussic acid—the record of the discovery of which reads like a veritable romance of science. The sight of the words "Scheele's Prussic Acid" should appeal to every one engaged in pharmacy to respect his profession, and strike a sympathetic chord, encouraging even the humblest worker to persevere in self-denying labors, never doubting that they will in some degree help to maintain the prestige conferred on the art

* In Sweden the superintendence and inspection of medical and pharmaceutical establishments are in the charge of a medical college, the members of which are nominated by the king. *Apotekervs* or pharmacists must register the names of their apprentices at the college and provide for instruction in botany, chemistry, and pharmacy, during the years of apprenticeship, at the expiration of which an examination is undergone which entitles those who pass to act as assistants. After serving awhile in this capacity, attendance on courses of lectures, practice in a laboratory, and a satisfactory private trial of capacity by the professors, are insisted upon before admittance to an examination conducted before the medical college. This passed, the examinee must take an oath to comply with the laws and regulations affecting pharmacy, after which he is granted a diploma as "Provisor and Apotekare," and is entitled to purchase a business if one should happen to be required in any district.

by the distinguished Swede, of whom his countrymen and fellow craftsmen have such strong reason to boast. The record of this and his other work will always constitute his best and most enduring monument; and the characteristics displayed in his writings, the concentration of effort, far-sightedness in arrangement, persistence in following up clews, energy in working out results and accuracy and completeness in final statements of results—properly descriptive in this case no less than in that of Faraday, to whom they are ascribed by Clark Maxwell—will ever cause to be included in the list of those whom posterity will delight to remember with gratitude and reverence the name of Carl Wilhelm Scheele.

References to Biographies.

Scheele, Charles William, Some Account of the Life of. By L. Von Creil. Creil's "Chemical Journal:" London, 1791.

Scheele, chemiste suedois. Etude biographique. By P. A. Cap: Paris, 1863.

Scheele, Karl Wilhelm. By John Ferguson. "Encyclopædia Britannica," ninth edition, 1886.

Scheele, Carl Wilhelm. Ett minnesblad pa hundrade arsdagen af hans dod af Dr. P. T. Cleve: Koping, 1886.

Scheele, Carl Wilhelm. Briefe und Aufzeichnungen. Edited by A. E. Nordenskiold: Stockholm, 1892.—*Pharmaceutical Journal.*

VERDI, THE COMPOSER.

A GREAT deal of mystery is being observed respecting Verdi's new opera, "Falstaff," which is to be produced at Milan this month. Press representatives are being excluded from all the rehearsals, and little or nothing will be known about the *mise en scene* until the actual production before the public. This secrecy is due to the express wish of the composer himself; indeed, if he could have had his own way, his first comic opera would have burst as a surprise upon the musical world in its complete and final form, instead of being made the subject of anticipation and discussion for at least two years beforehand. So he himself told me in an interview which I had with him recently at Genoa.

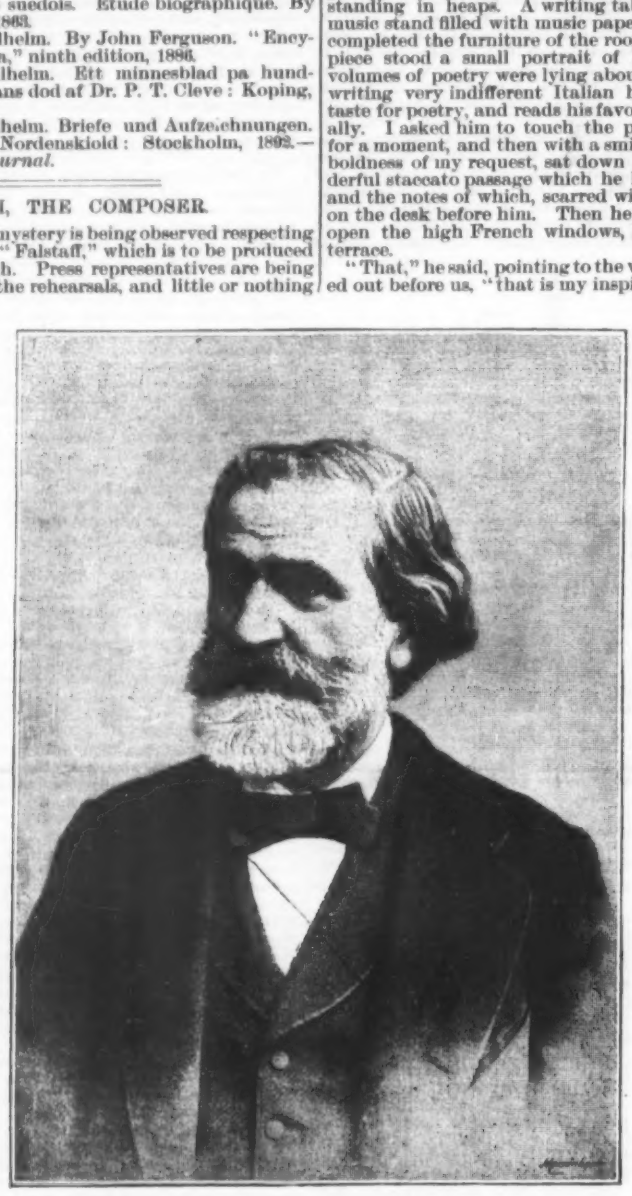
"This is the last work of my life," he said angrily, striding, a tall, gaunt figure, up and down his large drawing room, and pushing back the long gray hair from his wrinkled forehead with an impatient gesture. "I am writing it for my own amusement. The public would have known nothing about it had it not been for that *Mefistofele* of a Boito! (*quel Mefistofele di Boito*)."

This little joke of his own, more perfect in Italian than in English, put him into a good humor again, and on my asking what his complaint was against his clever librettist, he told me the whole story. They had been dining at the Hotel Milan with Ricordi, the music publisher, his wife and one or two more. When dessert was on the table Ricordi, turning to Boito, inquired when his "Nerone," an opera for which the Italian public has been waiting for the last five years, would be ready. Boito replied that it had been laid aside in view of a work of much greater importance, and then rising with his glass in his hand looked toward Verdi and said laughing: "Here's to your fat-paunched hero." Inquiries, of course, followed, and in this way the subject of the new opera became known.

"I should not have forgiven Boito his indiscretion," Verdi continued, "had he not written me a first-rate libretto. The music that I have put to it is in some passages so droll that it has often made me laugh while writing it."

I thought of the splendid death scene in *La Traviata*, and then of Aida's mournful "O terra, addio," and wished that the old *maestro* had not lived to employ his magnificent genius for the purpose of making himself or others laugh. My reflections were interrupted by Verdi inviting us into his *sanctum sanctorum*—the little, scantily-furnished study in which so much of his splendid music has been written. The other visitor present was Carducci, the Tennyson of Italy, who is in literature what Verdi is in music, and it was owing to the fact that I had been introduced by him that Verdi, usually harsh and unapproachable, had received me with marked kindness and cordiality. To be allowed—nay, asked—to enter his study was a special mark of favor. It is a tiny apartment, opening off the drawing room, and more than half filled by a grand piano on which, when I saw it, the manuscript of the new opera, written, as is the composer's custom, in pencil, and in very minute characters, was lying or standing in heaps. A writing table in the window, a music stand filled with music paper, and a single chair completed the furniture of the room. On the mantelpiece stood a small portrait of Mascagni, and some volumes of poetry were lying about, for Verdi, though writing very indifferent Italian himself, has a strong taste for poetry, and reads his favorite authors continually. I asked him to touch the piano. He hesitated for a moment, and then with a smile, no doubt at the boldness of my request, sat down and ran over a wonderful staccato passage which he had just completed, and the notes of which, scarred with corrections, stood on the desk before him. Then he rose, and throwing open the high French windows, led us out upon the terrace.

"That," he said, pointing to the view that lay stretched out before us, "that is my inspiration."



GIUSEPPE VERDI, THE COMPOSER.

The terrace overlooked a large neglected garden at the back of the old *palazzo* in which the composer lives. Beyond a slight elevation of ground, which hides a dusty road that intervenes, lies the open expanse of the Gulf of Genoa, closed toward the right by villa-covered hills and toward the left by the busy town and the docks crowded with shipping. The deserted overgrown garden, with its irregularity of surface, its pillars lying where they have fallen from their places in the portico below, and its moss-covered, dried-up fountain is seen cold and gray and still against the brilliant coloring of the sea, studded with its passing steamers and white-sailed yachts. It is here that Verdi lives and works for half the year, the remaining six months being spent at Busseto in his native province of Parma.

The terrace on which we stood was lined with pots of camellias and geraniums. They presented rather a decrepit and dried-up appearance, but Signora Verdi had previously told me that they were her husband's special weakness and that he always insisted upon watering and tending them himself. She went, indeed, so far as to say that the composer was far less angry with Mascagni for appropriating some of his melodies than he had been with a certain English visitor, bearing a well-known name, who had gained admission during Verdi's absence, and, anxious to carry off some souvenir, had possessed himself of a half-withered blossom. Bearing these facts in mind, I was duly impressed when Verdi now plucked one of the flowers and presented it to me with the grandest air in the world.

Then the conversation turned once more upon music. The inevitable organ grinder had struck up the equally inevitable selection from *Il Trovatore* on the roadway some distance off. I asked the composer whether he did not find this method of rendering his music peculiarly irritating.

"No," he replied; "on the contrary, it pleases me." Then he turned suddenly to the poet.

"Carducci, how should you like to hear the people massacring your songs and poems through the public streets? You would eat them alive, *non e vero?*"

The great republican poet, whose classicism has always rendered his writings *caviare* to the general, shook his leonine head.

"No," he replied; "not at all. I love the people, though I love them as an ideal, not as an assemblage of ignorant and vulgar individuals, and perhaps that is why they do not understand me. With you it is very different. Your melodies have become part of the national life."

"Ah," said Verdi, "the people have always been my best friends—from the very beginning. It was a handful of carpenters who gave me my first real assurance of success."

I scented a story and asked for details.

"It was after I had dragged on in poverty and disappointment for a long time at Busseto, and had been laughed at by all the publishers, and shown to the door by all the impresarios. I had lost all real confidence and courage, but through sheer obstinacy I succeeded in getting *Nabucco*"—so the title of *Nabucodonosor* is commonly contracted in Italy—"rehearsed at the Scala, in Milan. The artists were singing as badly as they knew how, and the orchestra seemed to be bent only upon drowning the noise of the workmen who were busy making alterations in the building. Presently the chorus began to sing, as carelessly as before, the '*Va, pensiero,*' but before they had got through half a dozen bars the theater was as still as a church. The men had left off their work, one by one, and there they were, sitting about on the ladders and scaffolding, listening! When the number was finished they broke out into the noisiest applause I have ever heard, crying, '*Bravo, bravo, viva il maestro!*' and beating on the woodwork with their tools. Then I knew what the future had in store for me."

His keen blue eyes assumed for a moment a gentle look such as is rarely seen in them. Ordinarily Verdi views the world from under his gray, shaggy eyebrows with a stern and forbidding expression, and he rarely speaks about himself. He shrinks habitually from anything that tends to bring him into any but the most formal relations with his fellow men, and so far does he carry this peculiarity that he likes even those who know him best to pass him in the street without saluting him, or showing that they are aware of his presence.

When we took our leave Verdi accompanied us to the door. I mentioned that I was starting that evening for Sicily, the country of the *Cavalleria Rusticana*.

"*A proposito,*" I asked, "have you heard what every one is saying about you? They say you have declared that you can die happy now that Mascagni's opera has been written. Is it true, *maestro?*"

Verdi shook his head rather gravely.

"Ah, no," he said. "Not yet. Not yet."—*London Daily Graphic.*

A NEW ELECTRIC FURNACE.

By HENRI MOISSAN.

THE discovery of the oxygen blast, by Henri Sainte-Claire Deville and Debray, rendered great services to chemistry. By means of this apparatus it has not only been easy to melt and refine platinum and to obtain new alloys, but also to extend and generalize a certain number of questions in mineral chemistry.

The temperature which may be reached with this apparatus fed with coal gas and oxygen is about 2,000°. We know that Deville and Debray found no substance except quicklime to resist this temperature.

Having had occasion in former researches to submit various substances to a temperature exceeding 2,000°, I thought of utilizing the heat yielded by the electric arc. After some trials I finally adopted the arrangement which I submit to the academy, the only claim of which is its extreme simplicity.

This new furnace is formed of two bricks of quicklime, carefully cut and placed one above the other. The lower brick has a longitudinal groove which receives the two electrodes, and in the middle is a small cavity which serves as a crucible. This cavity may be more or less deep, and contains a layer, some centimeters in thickness, of the substance upon which the thermic energy of the arc is to act. Or we may also arrange a small crucible of charcoal containing the substance to be ignited. Or for the reduction of oxides and the subsequent fusion of the metals we use larger crucibles, and a cylindrical aperture made in the upper brick allows of throwing from time to time into the furnace small packets formed of a compressed mixture of oxide and of carbon. The furnace, therefore, receives merely a single arc, and the diameter of the carbons which serve as conductors will, of course, vary with the intensity of the current. After each experiment the ends of the carbons are entirely converted into graphite.

In our first researches we used a small Edison machine driven by a gas engine of four horse power. Most commonly the current traversing the furnace indicated 30 amperes and 55 volts. The temperature reached did not much exceed 2,250°. In a second series of experiments we utilized the force produced by an eight horse power gas engine. The apparatus for measuring indicated 100 amperes and 45 volts. The temperature reached was about 2,500°. Lastly, thanks to the kindness of M. Violle, we were able to carry out our third series of experiments at the Conservatoire des Arts et Metiers. We had at our disposal a force of fifty horse power, and the arc obtained under these conditions measured up to 450 amperes and 70 volts. The temperature was about 3,000°. We are bound to address our thanks to M. Tresca, whose kind assistance proved very useful to us in this last series of experiments.

When employing high tension currents it is very useful to take certain precautions and to insulate the conductors with care. But even with currents of 30 amperes and 50 volts, such as those employed at the outset of these investigations, it is imperative not to expose the face to a prolonged action of the electric light, and always to protect the eyes with spectacles having very deep colored glasses. Electric sun strokes were very frequent at the beginning of these researches;

the irritation of the eyes produced by the arc may occasion very painful congestions.

The temperatures obtained in this series of experiments are only given approximately But M. Violle, not content with furnishing the means to carry out this research, has kindly undertaken the special determination of those different temperatures by procedures which he will lay before the academy at an early date.

When we became accustomed to the management of this furnace, we were able to produce a number of reactions which we will briefly summarize.

When the temperature is close upon 2,500°, lime, strontia, and magnesia crystallize in a few minutes. If the temperature reaches 3,000°, even the material of the furnace, quicklime, melts and flows like water. At the same temperature, carbon quickly reduces calcium oxide, and the metal is liberated in abundance. It readily combines with the carbons of the electrodes, forming a calcium carbide, liquid at a red heat, and easy to collect. Chromium sesquioxide and magnetic iron oxide melt rapidly at 2,250°. Uranium sesquioxide if heated by itself is reduced to the state of black uranous oxide, forming long prisms. Uranium oxide, which cannot be reduced by charcoal at the highest temperatures of our furnaces, is quickly reduced at 3,000°. In ten minutes it is easy to obtain an ingot of 130 grm. of uranium.

The oxides of nickel, cobalt, manganese, and chrome are reduced by charcoal at 2,500° in a few moments. This is a fine experiment for a course of lectures, as it does not require more than from ten to fifteen minutes.

This method enables us easily to cause boron and silicon to react upon the metals and to obtain borides and silicides in very fine crystals. Lastly, it is easy under the above conditions to cause this elevated temperature to act upon a number of substances, simple and compound.

We are continuing this study, and shall soon communicate our further results to the academy.—*Comptes Rendus*, CXV., p. 1031; *Chem. News.*

HOW A CROCODILE SEIZES AN OX.

THE Notawani is not an attractive river to the eye. It glides in sullen reaches and deep pools over a bed of alluvial deposit, which keeps the waters always discolored. When the volume of its flow is not increased by floods, it passes between deep banks that give it the artificial appearance characteristic of a canal. Near the Notawani, but on the margin of the Crocodile River, stands the well-known boom-slang tree. Few traders and ivory hunters, in days gone by, passed its widespread umbrageous branches without outspanning underneath its shadow. The situation is charming; on a grassy bluff stands this forest monarch, while the clear river sweeps round its base in a bold curve, fretting against both banks, as if the pellucid waters remonstrated against the restriction of being compelled to remain within earthly boundaries.

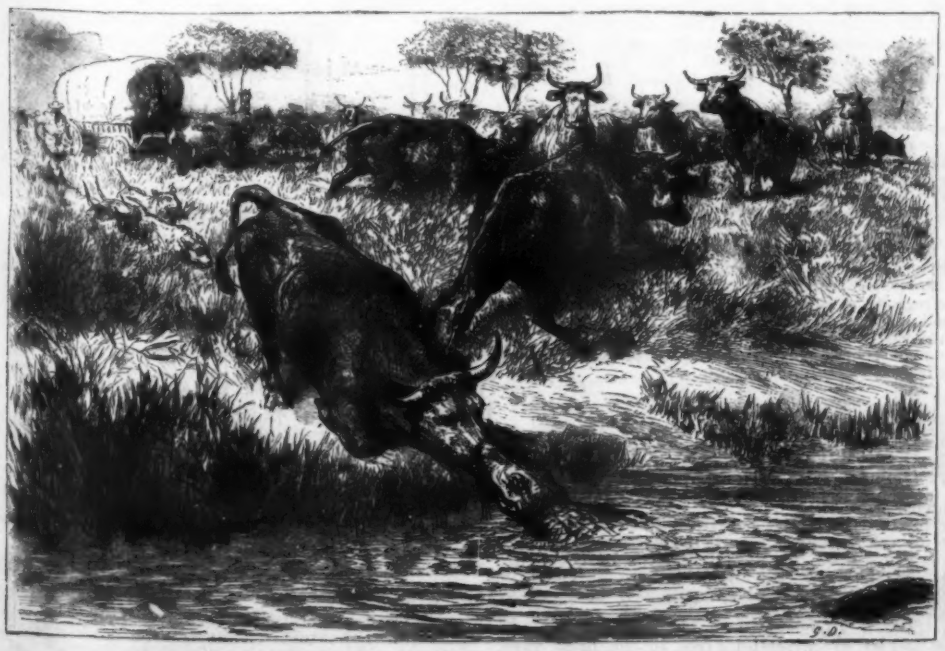
I have visited the drift across the Notawani and the boom-slang tree three times. On the first occasion a family of lions killed a most valuable salted horse belonging to my companion. On the second my favorite greyhound was struck by a ring-kaal snake, and on the third and last trip a favorite ox was so torn and mutilated by a crocodile that out of feelings of humanity I was obliged to shoot the valuable beast. However, I had my revenge, for two days afterward, adjoining the place where my cattle watered, I shot a giant saurian that I had little doubt was the brute that caused my loss, as it had a wound near the eye inflicted by my driver.

This is how the affair occurred: I crossed the drift over the Notawani a short time before sunset, this difficulty being satisfactorily accomplished when prospecting the neighborhood. I then saw a large crocodile, but a charge of shot about his muzzle sent him off at express speed. Nevertheless I cautioned my attendants to use every possible means to learn that the marauder was absent when my beasts were permitted to drink. But the natives, however careful they may be of their own belongings, are often very careless about their master's property, so disobeyed my instructions.

As I was absent when the casualty took place, after investigation disclosed the following: about an hour before midday—for oxen will not drink till the sun is high in the heavens—my voorloupers took the cattle to water. Among them was a very pretty black and white ox, by name Gilbert. This trifle I state for the information of the uninitiated in trecking, every bullock having a name. A better draught beast never had his head in a yoke, but, on account of his youth, or natural timidity of character, he was sadly bullied by all his companions. Thus Gilbert did not enter the water to slake his thirst until the others were satisfied. The voorloupers, who also perform the duty of herds, were probably at this time lying in the adjoining bush asleep. Anyhow, they were reminded of the responsibility of their duties by the sudden stampede of the team and a fearful struggle that was taking place at the edge of the river. They were unarmed, so could do nothing but shout for assistance. This turned out the camp followers as well as my head driver. All instantly picked up some weapon of more or less utility, but the last worthy, fortunately, had at hand his *roer*—a large-bore musket—which, on this occasion, did excellent service, for it doubtless was the means of driving off the marauder. But for this timely aid, I was assured by those present that in a minute or two more my ox would have been dragged into the river. This I can well imagine, for the grip that the crocodile had of Gilbert's head could not fail to have ultimately smothered him and thus deprived him of all powers of resistance.

A revengeful spirit is not always commendable, but on such an occasion as I have told of it assuredly is pardonable. Knowing that there is nothing that these saurians prefer as an article of diet to a dog, I had an ownerless and very worthless Kaffir cur picketed out near the cattle's drinking place, while I took up a commanding, but unobserved, position within twenty yards of the lure. When left alone the unfortunate commenced to make a most diabolical row. This was exactly what was desired.

After a wait of about twenty minutes, a snout, afterward the forequarters of the crocodile appeared. But this mammoth brute was as cautious as he was aged. The poor dog was in a fearful state, but I did not keep it long so, for its foe soon exposed a vulnerable spot, into which I promptly placed a pair of No. 10 bullets, propelled by seven drachms of gunpowder. Our illustration is from a sketch by Col. Parker Gillmore.—*London Graphic.*

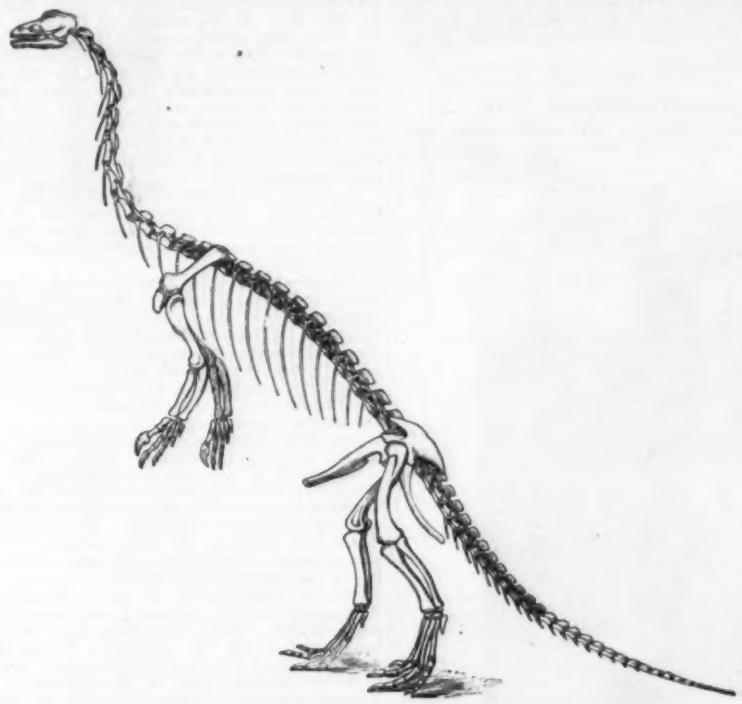


CROCODILE SEIZING AN OX.

RESTORATION OF ANCHISAURUS.

By O. C. MARSH.

THE Triassic dinosaurs now known from the Connecticut River sandstone have been investigated by the writer, and some of the results have already been placed on record. Remains of five individuals have been discovered sufficiently well preserved to indicate the main characters of the animals to which they pertained. These were all carnivorous forms of moderate size, and the known remains are from essentially the same geological horizon. Many larger forms, probably herbivorous, are indicated by footprints, but no characteristic portions of the skeleton have yet been found.



RESTORATION OF ANCHISAURUS COLURUS, MARSH.
(One-twelfth natural size.)

The genus *Anchisaurus*, one of the oldest known members of the *Theropoda*, is so well represented by parts of four skeletons—two nearly complete—from these deposits, that a restoration of one species can now be made with considerable certainty. This has been attempted, and the result is given, one-twelfth natural size, in the accompanying figure. The animal, when alive, was about six feet in length.

The skeleton chosen for this restoration is the type specimen of *Anchisaurus colurus*, already described by the writer. This skeleton when discovered was entire, and apparently in the position in which the animal died. Portions of the neck and the tail vertebræ were, unfortunately, lost before the importance of the specimen was realized, but the skull and nearly all the rest of the skeleton were saved. From these the matrix in great part has been removed, so that the more important characters can be made out with certainty. The parts missing are, fortunately, preserved in a smaller specimen of an allied species (*Anchisaurus solus*) found at the same locality, and these have been used to complete the outline of the restoration. Portions of two other specimens, nearly allied, and from the same horizon, were also available, and furnished some suggestions of value.

The restoration, as shown herewith, indicates that *Anchisaurus colurus* was one of the most slender and delicate dinosaurs yet discovered, being only surpassed in this respect by some of the smaller bird-like forms of the Jurassic. The position chosen is one that must have been habitually assumed by the animal during life, but the comparatively large fore limbs suggest the possibility of motion on all four feet. The compressed terminal digits of the fore feet, however, must have been covered by very sharp claws, which were used mainly for prehension, and not for locomotion.

The small head and bird-like neck are especially noticeable. The ribs of the neck and trunk are very slender. The tail apparently differed from that of any other dinosaur hitherto described, as it was evidently quite slender and flexible. The short neural spines and the diminutive chevrons directed backward indicate a tail not compressed, but nearly round, and one usually carried free from the ground.

The present restoration will tend to clear up one point long in doubt. The so-called "bird tracks" of the Connecticut River sandstone have been a fruitful subject of discussion for half a century or more. That some of these were not made by birds has already been clearly demonstrated by finding with them the impressions of fore feet, similar to those made by reptiles. Although no osseous remains were found with them, others have been regarded as footprints of birds, because it was supposed that birds alone could make such series of bipedal, three-toed tracks and leave no impression of a tail.

It is now evident, however, that a dinosaurian reptile like *Anchisaurus* and its near allies must have made footprints very similar to, if not identical with, the "bird tracks" of this horizon. On a firm but moist beach, only three-toed impressions would have been

left by the hind feet, and the tail could have been kept free from the ground. On a soft, muddy shore, the claw of the first digit of the hind foot would have left its mark, and perhaps the tail also would have touched the ground. Such additional impressions the writer has observed in various series of typical "bird tracks" in the Connecticut sandstone, and all of them were probably made by dinosaurian reptiles. No tracks of true birds are known in this horizon.

The genus *Ammosaurus*, represented by remains of larger size from the same strata, was a typical carnivorous dinosaur, and apparently a near ally of *Anchisaurus*. So far as at present known, the footprints of the two reptiles would be very similar, differing mainly in size.

The only other reptile known from the Connecticut sandstone by any part of the skeleton is a large *Belodon* from a lower horizon. This crocodilian may be called *Belodon validus*, and will be described by the writer later.—*Amer. Jour.*

THE CLARET-COLORED VINE.

THIS pretty vine, which is not nearly enough used in our gardens, we saw in Mrs. Earle's garden, the

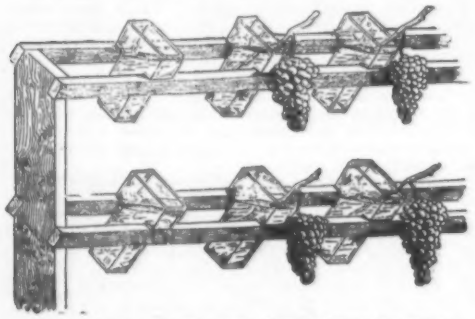
THE CLARET-COLORED VINE.

(Engraved for *The Garden* from a plant growing at the Woodlands, Cobham.)

Woodlands, Cobham, trained to a single stake, as shown in our cut. This vine, or one very like it, is very commonly grown in the fields in Touraine and other parts of France for coloring wine, and therefore cannot be difficult to obtain in quantity, if nurserymen so wish it. It should be planted occasionally in groups on dry banks, as well as against the house and trellises.—*The Garden.*

KEEPING LATE GRAPES.

THE accompanying illustration represents a capital glass which is use by Mr. Stanton, of Park Place, Henley-on-Thames, for keeping grapes. It is a great im-



GLASSES IN PLACE OF BOTTLES FOR KEEPING GRAPES.

provement on the bottles generally used, and is very cheap. The receptacle is made of clear glass, and having a wide mouth, water can be easily added from a small watering can as required without the trouble of taking it down or removing the grapes. Having square sides, too, it may be moved along in the racks to suit the size of the bunches, as there is no need to fix it, the rails being just sufficient distance apart to admit the bottles between, and fixed at such an angle, as illustrated, that the bunches hang clear. The weight of the bunch will press the immersed end of the stem against the upper side of the bottle, and so prevent its slipping out. It may be urged that as Alicante and Lady Downe's—two of our best late grapes—often produce their best bunches near the main stem of the vine, such bunches could not be kept in these bottles through the stem at the base being too short; but there is no difficulty in this, as the grapes will keep very well if the terminal end of the shoot be inserted in the bottles. It is always best to leave about eighteen inches of stem beyond the bunch when the grapes are cut, as otherwise the berries are apt to crack through absorbing too much of the water when first stored. It is well also to cut off the immersed end about once in three weeks to maintain a free passage for absorption. —*W. H. Lees, in The Garden.*

THE EUCALYPTUS.*

By W. C. TYNDALE, of Chicago, Ill.

THE eucalyptus tree is a native of Australia and Tasmania, where it forms large forests. There are about 140 species described, but they vary extremely, different kinds of leaves being produced on the same tree, thus presenting distinct specific characters and varying also in the nature of their barks.

In Tasmania and Gippsland, Victoria, they grow to an immense height, often exceeding 400 feet. Their naked and branchless stems of a dirty white color look like natural columns. These are often blackened by the fires of the natives or rung by the settler's ax, when they afford a grand but dismal spectacle, as one speeds along in the train; in some districts square miles of country are passed in which the forests have been rung preparatory to settlement, and in some cases for no obvious reason, as the land is unfit for occupation, and there stand those former monarchs of the forest like giant skeletons, sapless, lifeless-looking, dismal and forlorn in the midst oftentimes of a luxuriant undergrowth.

The trees are named usually according to the nature of their bark, which they shed instead of their leaves, such as stringy bark (*E. obliqua*), iron bark (*E. Sideroxylon*), blue gum (*E. Globulus*), peppermint tree (*E. amygdalina*).

The wood of some is very hard and durable, and so heavy as to sink in water. Many yield a kind of resin or gum, such as *E. resinifera* and *E. amygdalina*. A volatile oil of wonderful medicinal qualities is also produced from the leaves of various kinds, but more especially from that known as the *E. amygdalina*, which is the most productive, and yields nine-tenths of the oil of commerce, though not always placed in the market under its own name.

This arises from a certain amount of notoriety gained for the *E. Globulus* abroad, owing to the fact that it is the easiest of the species to acclimatize. As a matter of fact, however, there is scarcely any *E. Globulus* distilled in Australia. *E. mannifera* yields sweet secretions analogous to manna. *E. Gunnii* furnishes a liquid that ferments and forms a kind of beer. They all produce abundance of seed, which vegetates freely and becomes naturalized in various countries.

The *E. amygdalina* or giant eucalyptus, called "waugara" by the natives, is also known as the peppermint tree. This is one of the most remarkable and important of all the plants in the whole creation. Viewed in its marvelous height when standing forth in its full development on the slopes or within the glens of mountain forests, it represents probably the tallest of all the trees of the globe. Regarded as a hard wood tree of rapid growth, it ranks foremost, and contemplated in respect to its yield of volatile oil from its copious foliage, it is unsurpassed and perhaps unequaled by any tree in the world. These qualities have made it become generally known, and much through the exertions of Baron Von Mueller this tree is now being introduced abroad with good results in countries subject to neither severe frosts nor intense moist heat. It assumes under different climatic and geologic conditions various forms. Thus, in the ravines of the cooler ranges it attains its greater height, combined with a perfect straightness of stem, while the bark strips so completely as to render the huge stem quite smooth and almost white.

In the more open country it is much smaller. Under these conditions it is called a "peppermint tree" in Victoria and Tasmania and a "messmate tree" in New South Wales.

In Victoria this tree often exceeds 400 feet in height. Such trees are found on the Black Spur, Upper Yarra Yarra and Upper Goulbourn. A fallen tree on the Dandenong ranges measured 420 feet. The length of the stem up to the first branch was 295 feet. The diameter of the stem where it was broken 365 feet from the root was three feet.

A still thicker tree in the same locality measured 53 feet in circumference three feet from the ground.

A tree near Mount Wellington, Tasmania, has been found which measured 12 feet in diameter 220 feet from the ground. Another tree was found 130 feet in circumference at the base. Within a square mile 100 trees could be counted with a circumference of at least 40 feet. At the foot of Mount Baw Baw, Victoria, is found the highest of the giant trees of Australia. This monster is 471 feet high, and another on the Cape Otway ranges is 415 feet in height. The final height is sometimes attained by a single branch pushing skyward.

It is a grand picture to see a mass of enormous tall trees of this kind with stems of mast-like straightness and clear whiteness so close together in the forest as to allow them space only toward the summit to send their scanty branches and sparse foliage to the free light.

The distillation of the oil was first initiated by Baron Von Mueller. *E. amygdalina* yields more oil than any of the other varieties, and is therefore almost solely employed for the purposes of distillation. It is also one of the best for subduing malarious effluvia in fever regions, although it does not grow abroad quite so well or quickly as *E. Globulus*.

The respective hygienic value of various trees may to some extent be judged by the percentage of oil in their leaves, as stated below:

	Per cent. of oil.
E. Amygdalina	3·313
E. Oleosa	1·250
E. Leucoxylon	1·060
E. Goniocalyx	0·914
E. Globulus	0·719

The lesser quantity of oil in *E. Globulus* is compensated for by vigor of its growth and early copiousness of its foliage. It readily adapts itself to other climates, and hence abroad nearly all varieties of the oil are known as *Globulus*. During the last twenty years the blue gum has come into high repute as a sanitary tree. A high authority states that the sewage system of large towns in warm climes would be simplified if each house had the evergreen gum tree in the back yard. The disinfecting and deodorizing virtues of the tree are unquestionable.

Flesh of any kind is as well preserved by eucalyptus as by creosote, while beef sprinkled with it will dry hard without putrefaction. It is fatal to bacteria and other micro-organisms. It may be injected into the veins and arteries of cadavers for purposes of preservation. It is also a good admixture in dressing gangrene.

* *Journal of the Amer. Med. Assoc.*; *Amer. Jour. Phar.*

THE LIQUEFACTION OF AIR.

PROFESSOR JAMES DEWAR recently lectured at the Royal Institution on "The Liquefaction of Air." There was an overflowing auditory, all standing room even being occupied. We follow the report given in *The Engineer*, London.

Professor Dewar stated that during the seven months since his last lecture he had, until within the last two months, seen no new liquid oxygen, and wished to have deferred the lecture until the end of the present session, but other influences prevailed. When he began to attack the optical and electrical properties of liquid oxygen and air, difficulties cropped up. The liquids were in rapid ebullition, and contained impurities rendering them opalescent; the deposition of moisture on the outsides of the containing vessels rendered the electrical and optical measurements unsatisfactory, and expense became a serious obstacle. His friend Mr. George Mackay and others then placed themselves in communication with a great City company, with the result that the Goldsmiths' Company had generously contributed a thousand pounds to continue the work.

He said that liquid ethylene was one of the chief agents employed in producing such low temperatures; it was the chief illuminating portion of coal gas; he exhibited some of it in a tube, covered with ice condensed from the aqueous vapor of the theater, connected the tube with a burner, and lit the escaping vapor emitted by the liquid boiling at the temperature of the air; the more he warmed it, say with the heat of the hand, the more it boiled and the longer grew the flame. Thus heat was being removed by the ebullition, but the liquid itself did not grow hotter than its boiling point temperature. This afforded an experimental means of measurement, and by means of the arrangement shown in Fig. 1, he proved that at the tempera-

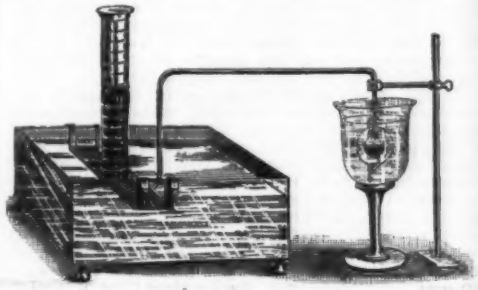


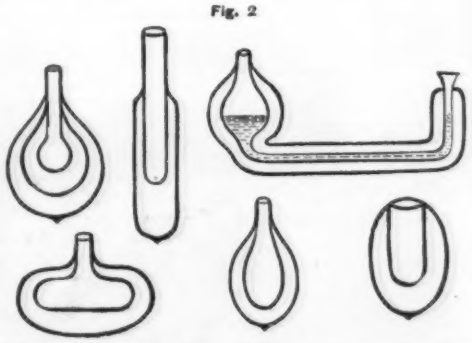
FIG. 1.

ture of the air 350 c. c. of gas were distilled in half a minute. On the one side of the cut is represented a vessel of water, in which is held by a retort stand the liquid ethylene in a bulb surrounded by another bulb, and between the two bulbs was a high vacuum; the bubbles of gas given off were received in a graduated inverted tubular vessel, for the measurement of the result. On surrounding the same bulb with solid carbonic acid to reduce the temperature to but 20° C. above the boiling point of ethylene, but 50 c. c. of gas were given off in the same time, by distillation.

To show the intense coldness of liquid ethylene, he poured some of it upon water; the two came into contact with a slight explosion, and ice was formed on the surface of the water. He said that the way to keep ethylene liquid for some little time was to surround it with a vessel containing boiling carbonic acid.

In his earlier work, in order to be able to handle these cold liquids, and to keep them longer, he had surrounded the glass containing vessel with two or more others, containing common air, as in the first vessel in Fig. 2, but he had afterward discovered that

Fig. 2



much better results were obtained by means of an exceedingly perfect vacuum between the two surfaces of glass, as indicated by the following table:

Rate of Evaporation.

Liquid oxygen, vacuum	170 c. c.
Liquid oxygen, air	840 c. c.
Liquid ethylene, vacuum	56 c. c.
Liquid ethylene, air	230 c. c.

The liquids could be kept five times longer by surrounding them with a vacuous space. Mr. E. Gimingham had, at great inconvenience and with much skill, done the glass blowing for him. He was the brother of the Mr. Gimingham who had done so much in this way to help Mr. Crookes. Professor Dewar then put some liquid oxygen into an unprotected glass vessel, which quickly became covered with ice, but in a vessel protected with a vacuum it boiled slowly and steadily, and he said that liquid oxygen would take about one

and a half hours to boil out of a small glass bulb protected by a high vacuum.

The lecturer then produced a temperature of —200° C. by causing a vacuum to act upon a large tube containing liquid oxygen. A small empty test tube inserted in the large tube was so cold that the air of the theater at ordinary pressure liquefied in it, and was seen trickling down its sides, and collecting into a mass of liquid at its bottom. This was made visible to all present by projection upon a screen by means of the electric lantern. He then showed that the temperature was so low that liquid oxygen would not cause a smouldering slip of wood to burst into flame. He also showed that liquid oxygen, when first formed, was opalescent. This he stated to be due to minute crystals of impurities, which in two or three minutes amalgamated into large crystals, so that the liquid then became transparent, with numerous specks moving in it when exhibited by optical projection.

In speaking of the magnetic properties of liquid oxygen at a temperature of —200° C., he soaked with it a small mass of cotton wool suspended at the end of a thread, and held it between the poles of the electro-magnet. The result was that it was attractive to one of the poles, which then sucked the liquid out of the wool, and it was in large part left boiling upon the pole.

The speaker next showed that liquid oxygen floats on water quite quietly—unlike ethylene—and makes thereupon little cups of ice for itself, it being in the spheroidal state, so as not to come into contact with the water. If liquid oxygen be poured upon water, as in W W, Fig. 3, and if before ice has begun to form the

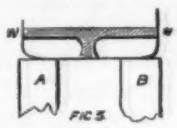


FIG 3

poles, A B, of an electro-magnet be made to act upon it, the oxygen is drawn down, as at K. This was shown by optical projection, and the experiment had to be quickly performed, as ice appears without much delay.

The oxygen and nitrogen of common air liquefy simultaneously, but they do not distill simultaneously; the nitrogen is a long time boiling off, and grows gradually richer in oxygen, but the bulk of the oxygen is left until last, especially as it is kept cool by the evaporating nitrogen. Unlike liquid oxygen, liquid common air boils furiously when acted upon by the normal temperature of the atmosphere.

Professor Dewar next drew attention to the pale blue color of liquid oxygen, which became more marked when he placed the tube containing it against a background of dead-white solid carbonic acid. He also showed its absorption bands by the aid of a spectrum projected upon the screen, and he drew attention to some difficult experiments performed last year by Professor Liveing and himself before the formation of ice on the outside of the containing vessels was to some extent prevented. For this purpose, as stated in the *Philosophical Magazine*, they used a glass tube of the form shown at A in Fig. 4, about ¾ in. in diameter and 3 in. in

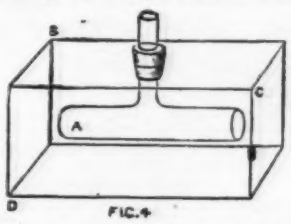


FIG.4

length. This tube had the ends blown as flat and clean as possible, and it was inclosed in a box with glass sides, B C D, and the air in the box well dried, in order to prevent the deposition of hoar frost on the tube. The liquid oxygen was poured into the tube at the pressure of the atmosphere, and at first boiled violently, until the tube was reduced to the temperature of boiling oxygen —181°, after which the liquid boiled slowly and quietly. Through the length of the tube—that is, a thickness of about 3 in. of liquid oxygen—they viewed the hot pole of an electric arc with a spectroscope, having two calcite prisms of 30° and one of 60°. As reference rays they used the red potassium lines, of which the positions with reference to A and B were well determined by Kirchhoff, and confirmed by their own observations. Liquid oxygen gives a few strong absorption bands, especially in the orange and yellow, and the experimenters agreed with Olszewski that the blue color of oxygen appears not to be due to ozone, which imparts an indigo-blue color to liquid oxygen. The speaker then drew attention to the following table:

Refractive Indices of Liquid Gases.

	Index.	Ref. Constant.	Ref. Molecular.
Oxygen.....	1·2236	1·989	6·364
Ethylene..... ...	13632	0·626	17·528
Nitrous oxide....	13305	0·263	11·587
Nitrogen.....	—	—	8·405

Law of Gladstone $\frac{\mu - 1}{D}$ = Constant.

Professor Dewar next dealt with the conductivity of metals, alloys, and carbon at excessively low temperatures. The experiments had been performed by Professor J. A. Fleming and himself by means of a resistance coil made as in Fig. 5, consisting of a piece of notched mica coiled with the fine wire to be tested, and of stout insulated copper rod connections. The results point to the conclusion that absolutely pure metals seem to have no resistance near the zero of temperature as indicated by the following curves—Fig. 6—obtained by experiment. With alloys there is little change in resistance, as indicated in the curves (Fig. 7). The conductivity of carbon decreases with low temperatures, and increases with high ones, as indicated by the diagram (Fig. 8). At the temperature of the electric arc, carbon appears to have no resistance.

Professor Dewar then drew attention to the properties of liquid common air, which is opalescent at first, but clears itself more quickly than oxygen, because of the carbonic acid freezing out; in fact, it seems to be a peculiarity of these intensely cold liquids that impurities have a tendency to freeze out. Under the magnet, when the oxygen of air is attracted, it drags up the inert nitrogen with it, and does not "suck out"

FIG. 5

the oxygen, as in the case of the experiment with cotton wool already described. He passed some of the liquid air through filtering paper, to get rid of the opalescence more quickly. He likewise, by means of a thermal junction and reflecting galvanometer, proved that liquid air has a fixed boiling point. By the evaporation of air he reached a temperature of about —200 deg. C.

Professor Dewar then returned to the subject of the glass vessels shown in Fig. 1, and said that anything but a very high vacuum between the two glass sheaths was useless. To obtain exceedingly high vacua he

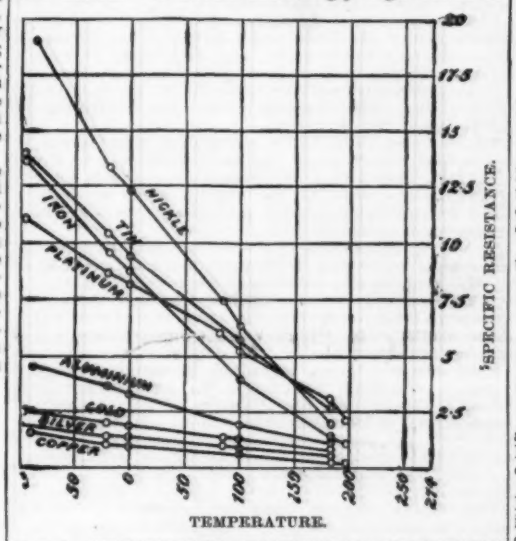


FIG. 6.—ELECTRICAL RESISTANCE OF METALS AT LOW TEMPERATURES.

had gone back to the old method of Torricelli, of inverting mercury in a tube so as to leave in its upper part nothing but the pressure of mercury vapor. His plan was to take a large bulb, K (Fig. 9), and a small one, W, filled with mercury, which also filled the tube, H, and its U-shaped continuation below. He then applied heat to K, and when the mercury was well below A, he sealed the tube at A. Next he rubbed liquid oxygen, by means of a plug of cotton wool, over the

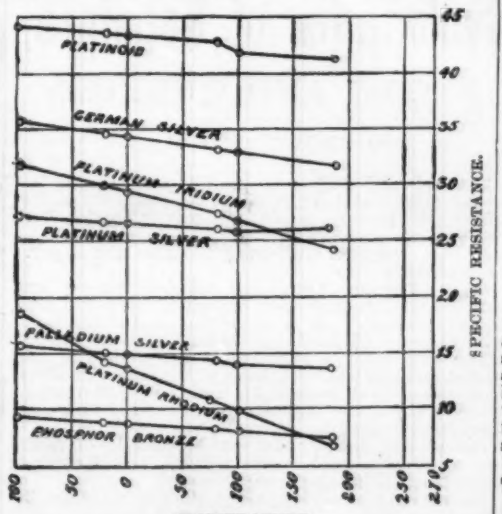


FIG. 7.—ELECTRICAL RESISTANCE OF ALLOYS AT LOW TEMPERATURES.

outside of the bulb, W, at the same time slightly heating the bulb, K, the result of which was that the trace of residual mercury vapor was practically all condensed as a mirror on part of the inner surface of the bulb, W, after which the larger bulb was sealed off at B. By this method he thought that a vacuum was obtained higher than any of which man had ever yet dreamed, and he based this opinion upon the following calculation:

Pressure of Mercury Vapor.

$$\text{Log. } P = 15{\cdot}1151 - 2{\cdot}2931 \text{ log. } T - \frac{3665{\cdot}7388}{T}$$

Pressure at 0 deg. C. = 0,000,126 m., or ¼ millionths of atmosphere.

Pressure at — 80 deg. C. = 0,000,000,006 or $\frac{4}{100{,}000}$

A vacuum like this could not be obtained by means of any mercury pump. He exhibited a vacuum bulb of this class, which did not conduct the electric discharge in the usual manner, but the surface of the glass became fluorescent under the action of electricity.

He expressed the opinion that those "night shining clouds," at a height of fifty or sixty miles, which of

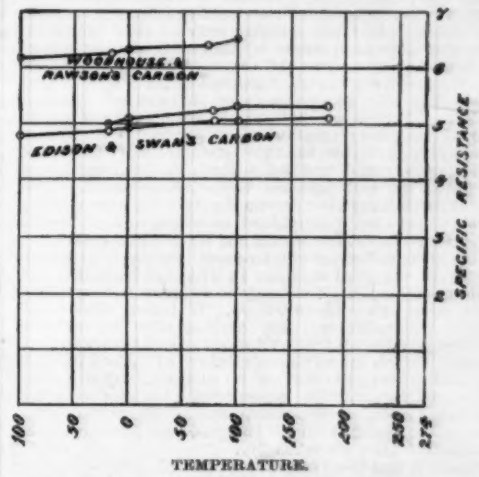


FIG. 8.—THE ELECTRICAL RESISTANCE OF CARBON AT LOW TEMPERATURES.

late years have been a subject of scientific observation and speculation, are probably clouds of particles of solid carbonic acid, the latter gas being a normal constituent of common air.

Professor Dewar gave the following table of radiation at low temperatures:

Radiation at Low Temperatures.

Temperature.	Radiation.
— 115 deg. C.....	60 c. c.
— 78 "	120 c. c.
+ 6 "	300 c. c.
+ 65 "	600 c. c.

Lastly, the lecturer expressed his appreciation of the arduous labors of his two assistants, Mr. Lennox and Mr. Heath, in preparing for the experiments of the evening.

As to the general principles on which Professor Dewar produces liquid oxygen and liquid common air in bulk, in the laboratory he has not alone the means of obtaining great compression, but has an exhausting pump, which will even keep up a pretty good vacuum in a large and slightly leaky vessel. He manufactures ethylene by heating a mixture of sulphuric acid and alcohol, and gets it into the liquid state by compressing it, and by cooling it by the evaporation of nitrous oxide. The lecture theater is, unfortunately for him, a long way from the laboratory, and liquid ethylene and liquid nitrous oxide are conveyed to it in pipes. In the theater are a number of concentric cylindrical vessels, the outer one perhaps 2 ft. high and 2 ft. in diameter, and coated outside with flannel; the whole is somewhat on the principle of the ammonia freezing apparatus. The nitrous oxide enters the outside vessel, in which it can be made to evaporate furiously, and the ethylene is violently evaporated immediately outside the central vessel, which thereby becomes so cold as to liquefy oxygen or common air. He promotes rapid evaporation of the liquids used for cooling, by means of a vacuum. These liquids move in closed circuits, so no vapor escapes into the theater; the nitrous oxide and the ethylene thus are not lost, but are used over and over again. Nitrous oxide liquefies

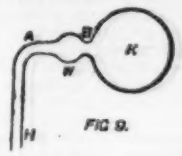


FIG 9.

at —90° C. (—130° F.) at a pressure of 1,800 lb. to the square inch. Ethylene liquefies at —100° C. (—148° F.) at a pressure of 750 lb. to the square inch. Liquid ethylene, in evaporating, gives a temperature of —145° C., at which stage, with a pressure of 750 lb., oxygen liquefies. Nitrogen liquefies at about —350° F. with a pressure of 525 lb.

THE IMPORTANCE OF "NEXT-TO-NOTHING" IN CHEMISTRY.

By W. H. PENDLEBURY, M.A. (Oxon.), Science Lecturer of Dover College, England.

IN the year 1888 the president of the British Association for the Advancement of Science took for the subject of his inaugural address "The Importance of 'Next-to-Nothing.'" As a matter of course, Sir Frederick Bramwell treated his subject with his usual wit and ability, and pointed out the influence of small things on the advancement of his particular branch of science—engineering. It might, however, be well

to carry the idea still further and to collect together, as far as is possible in a short paper, the facts that have come to light showing the influence of traces of a foreign substance upon chemical change. Some of the facts are almost paradoxical. Take the case of an ordinary coal fire, which was probably one of the first objects which aroused the interest and curiosity of mankind and awakened the instinct of scientific investigation. It is needless to refer to the erroneous views held on the subject of combustion, but it may just be mentioned that the discovery of oxygen seemed to settle the matter and to establish on a firm basis the whole theory of combustion. In the years 1887 and 1888* the experiments of Mr. H. B. Baker made it quite clear, however, that the presence of aqueous vapor had a great deal more to do with combustion, and hence the burning of an ordinary coal fire, than we were aware of. He showed that if oxygen be rendered perfectly dry, by leaving it for some time in contact with phosphorus pentoxide, combustion is rendered impossible in such gas. Carbon, sulphur, or phosphorus may be strongly heated in an atmosphere of perfectly dry oxygen without taking fire, and, in fact, the sulphur and phosphorus may be distilled in it. The presence of a trace of moisture at once brings about the combustion. The writer has seen Mr. Baker distill phosphorus in an atmosphere of oxygen, and then, while the phosphorus was still melted, admit a bubble of oxygen which has been standing over water, and at once the phosphorus burst into flame. Hence it is highly probable that the ordinary phenomena of combustion could not take place in our atmosphere if there were not aqueous vapor also present. This would furnish another reason against the probability of the moon's being inhabited, as, owing to the absence of aqueous vapor, fire would not be possible there.

The great influence of a trace of moisture in bringing about chemical changes in which of itself it is not directly concerned, if we may so express it, is evident from many other observations. Wanklyn discovered that dry chlorine will not combine with dry metallic sodium, but that a trace of moisture will start the reaction. Dixon found that a mixture of carbon monoxide and dry oxygen will not be exploded by the electric spark, but that the presence of a trace of moisture will bring about a silent combination under the influence of the spark, while, if the gases are moist, the explosion will take place readily.

Again, it has been recently observed that ethylene and oxygen, when perfectly dry, do not explode when acted upon by the electric spark, but the presence of moisture acts in this case as in the former.

Again, carbon dioxide is not absorbed by dry lime. Sulphureted hydrogen in the dry condition does not tarnish dry silver. Dry iodine does not decompose dry sulphureted hydrogen.

We may take another example of the influence of next-to-nothing of an impurity in bringing about a change in which its influence had been till lately little regarded. The experiments of Mr. V. H. Veley,† of Oxford University Museum, on the action of nitric acid on various metals, has conclusively shown that the violent action which nitric acid has upon many metals is due to the presence of a trace of nitrous acid in the nitric. He has kept spheres of copper in the strongest nitric acid (freed from the presence of nitrous acid) for some time without any reaction occurring, but when once a trace of nitrous acid or of any nitrite was added, the copper was at once dissolved. The same kind of result was observed when mercury, silver, or bismuth were exchanged for the copper. It was found that from 1 to 2 parts of nitrous acid in 10,000 of the nitric were sufficient to set up the reaction.

Mr. Cross found that jute fiber, when treated with sulphuric acid, is simply hydrolyzed. If, however, ordinary nitric acid, containing a trace of nitrous acid, be allowed to act on the jute, a considerable amount of chemical action takes place, and among other substances, like urea, which either prevents the formation of nitrous acid or decomposes it as quickly as it is formed, the action of nitric acid on jute is strictly comparable with that of sulphuric acid, simple hydrolysis taking place.

It is highly probable that many of the changes in organic chemistry, generally ascribed to the action of nitric acid alone, are due to the presence of traces of nitrous acid.

It is well known that pure zinc will not dissolve in pure hydrochloric acid or pure sulphuric acid, but the presence of a trace of a metallic salt sets up the reaction very readily.

If we take another branch of chemistry—metallurgical chemistry—the immense importance of the presence or absence of a trace of a foreign substance in a metal is readily seen, since it produces an immediate effect on the hardness or tenacity of the metal, and so may destroy its usefulness in commerce. Take the case of copper: Professor Roberts-Austen states in his Cantor lectures that a cable made of the pure copper of to-day will carry twice as many messages as a similar cable made of the less pure copper of thirty-five years ago, when the importance of the purity of copper was not so well understood, and he quotes a saying of Sir William Thomson's, that the presence of one-tenth per cent. of bismuth in the copper of a cable would entirely destroy its commercial success by reducing its conductivity. Sir Hussey Vivian has stated that one-thousandth part of antimony will convert the best select copper into the worst conceivable. Another instance occurs in the case of iron. By the addition of two-tenths per cent. of carbon, steel is produced of such a kind as would make an excellent bridge or boiler plate, but if fashioned into a weapon would be absolutely untrustworthy. If, on the other hand, eight-tenths per cent. of carbon were introduced, a material is obtained from which a good razor might be made, but it would be useless for a rail or the construction of a bridge. A trace of manganese in steel renders it impossible to make a magnet out of such a specimen. It also prevents the hardening of such steel by rapid cooling after heating to redness.

The metal, however, which shows the most remarkable change in its physical properties when contaminated with next-to-nothing of a foreign substance is gold. The addition of two-tenths per cent. of bismuth would render a specimen of gold useless for coinage purposes, as it would crumble to powder under the pressure of the die. Lead acts in a similar way. One part of lead added to two thousand parts of gold reduces its tenacity from 18 tons per square inch to only 5 tons. A bar of such gold can be readily broken by a tap from a hammer. The color of the gold is changed from yellow to orange brown. Such a remarkable change in the appearance and properties of gold on the addition of small quantities of other substances was known in the seventh century, and helped to confirm the belief of the alchemists that they had only to find some substance which would alter the properties and appearance of any given metal, so that it would change into and acquire the properties of gold. Hence the search for the philosopher's stone.

This paper might be indefinitely extended, but enough has probably been said to show that even in chemistry the day of small things is not to be despised, and that a thorough investigation of some of the commonest and best-known chemical changes would doubtless bring to light many facts at present overlooked, and would tend to a better understanding of the workings of nature.

* Proceedings of the Royal Society, vol. 45, and Phil. Trans., 1888.

† Philosophical Transactions, 1891.

THE SCIENTIFIC AMERICAN

Architects and Builders Edition

$2.50 a Year. Single Copies, 25 cts.

This is a Special Edition of the SCIENTIFIC AMERICAN, issued monthly—on the first day of the month. Each number contains about forty large quarto pages, equal to about two hundred ordinary book pages, forming, practically, a large and splendid **Magazine of Architecture**, richly adorned with *elegant plates in colors* and with fine engravings, illustrating the most interesting examples of modern Architectural Construction and allied subjects.

A special feature is the presentation in each number of a variety of the latest and best plans for private residences, city and country, including those of very moderate cost as well as the more expensive. Drawings in perspective and in color are given, together with full Plans, Specifications, Costs, Bills of Estimate, and Sheets of Details.

No other building paper contains so many plans, details, and specifications regularly presented as the SCIENTIFIC AMERICAN. Hundreds of dwellings have already been erected on the various plans we have issued during the past year, and many others are in process of construction.

Architects, Builders, and Owners will find this work valuable in furnishing fresh and useful suggestions. All who contemplate building or improving homes, or erecting structures of any kind, have before them in this work an almost *endless series of the latest and best examples* from which to make selections, thus saving time and money.

Many other subjects, including Sewerage, Piping, Lighting, Warming, Ventilating, Decorating, Laying out of Grounds, etc., are illustrated. An extensive Compendium of Manufacturers' Announcements is also given, in which the most reliable and approved Building Materials, Goods, Machines, Tools, and Appliances are described and illustrated, with addresses of the makers, etc.

The fullness, richness, cheapness, and convenience of this work have won for it the **Largest Circulation** of any Architectural publication in the world.

A Catalogue of valuable books on Architecture, Building, Carpentry, Masonry, Heating, Warming, Lighting, Ventilationa and all branches of industry pertaining to the art of Building, is supplied free of charge, sent to any address.

MUNN & CO., Publishers,
361 Broadway, New York.

THE SCIENTIFIC AMERICAN

Cyclopedia of Receipts,

NOTES AND QUERIES.

680 PAGES. PRICE $5.

This splendid work contains a careful compilation of the most useful Receipts and Replies given in the Notes and Queries of correspondents as published in the SCIENTIFIC AMERICAN during nearly half a century past; together with many valuable and important additions.

Over Twelve Thousand selected receipts are here collected; nearly every branch of the useful arts being represented. It is by far the most comprehensive volume of the kind ever placed before the public.

The work may be regarded as the product of the studies and practical experience of the ablest chemists and workers in all parts of the world; the information given being of the highest value, arranged and condensed in concise form, convenient for ready use.

Almost every inquiry that can be thought of, relating to formulæ used in the various manufacturing industries, will here be found answered.

Instructions for working many different processes in the arts are given. How to make and prepare many different articles and goods are set forth.

Those who are engaged in any branch of industry probably will find in this book much that is of practical value in their respective callings.

Those who are in search of independent business or employment, relating to the manufacture and sale of useful articles, will find in it hundreds of most excellent suggestions.

MUNN & CO., Publishers,
361 Broadway, New York.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. ARBORICULTURE.—The Eucalyptus.—By W. C. TYNDALE.—Details of the great Australian tree and its products. 14324

II. BIOGRAPHY.—Carl Wilhelm Scheele, Pharmacist and Chemist.—Life and work of the great chemist.—One of the founders of modern chemistry.—2 illustrations. 14329

Verdi, the Composer.—The great composer, and personal details.—His work and habits. 14329

III. CHEMISTRY.—The Importance of "Next-to-Nothing" in Chemistry.—By W. H. PENDLEBURY.—The effect of traces and impurities in chemical reactions. 14326

IV. CHRONOLOGY.—A Perpetual Mental Calendar.—By LYMANDER HILL.—A mental system for finding days of the week corresponding to days of the month. 14329

V. CIVIL ENGINEERING.—The New Station of the Philadelphia & Reading Terminal Railroad, Philadelphia, Pa.—The largest single span arched roof on any train shed in the world. 14325

VI. ELECTRICAL ENGINEERING.—A New Electric Furnace.—By HENRI MOISSAN.—An electric furnace of extreme simplicity utilizing the electric arc. 14327

VII. HORTICULTURE.—The Claret Colored Vine.—A very pretty vine available for garden and lawn cultivation.—1 illustration. 14328

VIII. MECHANICAL ENGINEERING.—Horse Power of Steam Boilers.—By WILLIAM GOLDING.—Heating surface rating for steam boilers. 14322

Pittler's Universal Tool.—A lathe constructed to do a great variety of operations.—14 illustrations. 14324

The Gas Engine.—Advantages of gas engines as compared with steam engines. 14323

IX. MISCELLANEOUS.—An Illumination in a Hat.—A trick in which a number of Chinese lanterns and other articles are extracted from an ordinary hat.—3 illustrations. 14319

A Professional Society which is not a Close Corporation.—The American Institute of Mining Engineers and how it is managed. 14323

A School in Persia.—Schools held in the open air upon the public road in Persia.—1 illustration. 14319

How a Crocodile Seizes an Ox.—An incident of African life.—1 illustration. 14321

Reminiscences of Penikese.—By Mrs. HELEN B. C. BEEDY.—The summer school at Penikese and the work done there in old days. 14320

Trick with an Egg and a Handkerchief.—A very good trick, with details of the apparatus used in its performance.—3 illustrations. 14318

X. NAVAL ENGINEERING.—A Large Floating Crane.—Details of the largest floating crane ever built, now in operation at Cramp's shipyard. 14325

The Monterey.—Description of the new twin-screw double-turreted coast defense vessel launched in May, 1891, at San Francisco.—2 illustrations. 14321

XI. PALÆONTOLOGY.—Restoration of Anchisaurus.—By O. C. MARSH.—A Triassic dinosaur of small size and delicate proportions.—1 illustration. 14326

XII. PHYSICS.—The Liquefaction of Air.—A most interesting article on Prof. Dewar's famous experiments with liquefied gases.—9 illustrations. 14324

XIII. PSYCHOLOGY.—The American Psychological Association.—The new association.—Its first regular meeting and work done there. 14320

XIV. RAILROAD ENGINEERING.—Steel in Rolling Stock.—The substitution of steel castings for forgings in railroad car construction. 14322

XV. TECHNOLOGY.—Asbestine.—A species of asbestos rock used for loading paper. 14318

Liquid Fuel for Steam Making.—By F. R. HUTTON.—The advantage of partially refined and of crude petroleum oil for boiler firing. 14315

Progress of the Sorghum Sugar Industry.—Satisfactory results obtained with sorghum sugar in Kansas. 14319

The Manufacture of Liquors and Preserves.—By J. DE BRUVANS.—Continuation of this treatise.—Opening of the subject of preserves.—Brandied fruits and formulæ for their preparation. 14317

Utilizing Petroleum Waste.—A preparation of petroleum waste for fuel by separating the water from it. 14317

XVI. VITICULTURE.—Keeping Late Grapes.—A system of keeping late grapes by special water vessels for the stems.—1 illustration. 14328

A New Catalogue of Valuable Papers

Contained in SCIENTIFIC AMERICAN SUPPLEMENT during the past ten years, sent *free of charge* to any address. MUNN & CO., 361 Broadway, New York.

Useful Engineering Books

Manufacturers, Agriculturists, Chemists, Engineers, Mechanics, Builders, men of leisure, and professional men, of all classes, need good books in the line of their respective callings. Our post office department permits the transmission of books through the mails at very small cost. A comprehensive catalogue of useful books by different authors, on more than fifty different subjects, has recently been published, for free circulation, at the office of this paper. Subjects classified with names of authors. Persons desiring a copy have only to ask for it, and it will be mailed to them. Address

MUNN & CO., 361 Broadway, New York.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had *forty-five years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. MUNN & Co. also attend to the preparation of Caveats, Copyrights for Books, Labels, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, on application, containing full information about Patents and how to procure them; directions concerning Labels, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases. Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws, showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York.

BRANCH OFFICES.—No. 622 and 624 F Street, Patent Building, near 7th Street, Washington, D. C.